ENHANCING INTEGRATION OF SPECIALISED EXERCISE TRAINING INTO COACH PRACTICE TO PREVENT LOWER-LIMB INJURY:

USING THEORY AND EXPLORING COACHES' SALIENT BELIEFS

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Abstract

Lower limb injuries (LLIs) are common in community-Australian football (CAF) and specialised exercise training (SET) programs can reduce their incidence. Despite the protection SET programs afford, the use of SET by coaches in CAF contexts, who play a key role in the preparation of players, is largely unknown. The overall purpose of this thesis research was to explore and describe: (1) the contextual and specific nature of CAF coaching practices, and, (2) the factors central to understanding whether or not coaches will make changes in their training practices in the future. Thereby, assisting to devise effective behaviour change and implementation strategies that maximise future integration (adoption and maintainence) of SET programs in CAF contexts to reduce the risk of LLIs for players.

This mixed methods research was underpinned by a combination of behavioural and social science theories and models (BSSTM). Coaches' were sampled from CAF clubs in Victoria and Western Australia. Eligible coaches completed cross-sectional questionnaires pre (n=31) and post (n=28) season in 2007/08. Three coaches engaged in semi-structured, in-depth interviews, 12-18 months later.

At preseason, 58% of coaches used injury prevention strategies with their team. Only 69% of them had a formal training plan for the entire season, and most did not explicitly incorporate SET programs, despite their views being favourable towards the latter. Coaches believed their players had a high chance of sustaining a LLI and that LLI could have serious consequences. They believed it was important to have current knowledge of SET programs, but many lacked the behavioural capability and self-efficacy to implement SET programs. They also reported that player attendance at training could also impact on SET program outcomes.

Postseason findings were similar with generally positive SET outcome expectancies; many coaches reported they intended to modify SET program implementation in future seasons. Suggested improvements related to collaboration, feedback/reinforcement approaches, education and other sociocultural themes. Coaches reported divergent views about their self-efficacy in relation to SET program implementation but were motivated by what their players thought.

Qualitative analysis of the in-depth interviews identified four main themes (and associated coach salient beliefs) that supported and extended quantitative findings. These included: (1) the development of coach behavioural capability/self-efficacy (including informal and formal learning sources), (2) biopsychosocial risk perceptions regarding players' injury susceptibility, (3) facilitators and hindrances to adopting/maintaining SET, and (4) cues to action/planning.

The promotion of SET programs to reduce the susceptibility of LLIs and ensure safe and sustainable participation in AF is important. This thesis has captured a complexity of factors that can be used to enhance and facilitate CAF coaches' adoption and maintenance of SET, alongside wider-prevention efforts. Future research should continue to use a range of BSSTM and methodological approaches, and devise and evaluate the efficacy of a comprehensive taxonomy of cognitive-behavioural strategies, to provide more insight into effective translation of SET programs into practice. Coaches and their players will be safer if such work continues.

Statement of Authorship

Except where explicit reference is made in the text of the thesis, this thesis contains no material published elsewhere or extracted in whole or in part from a thesis by which I have qualified for or been awarded another degree or diploma. No other person's work has been relied upon or used without due acknowledgment in the main text and bibliography of the thesis.

27/02/2015.

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Date

Statement of Ethics Approval

This thesis research was approved by the Human Research Ethics Committee of the University of Ballarat (currently known as Federation University Australia) (Project numbers: BO6-029 and B09-083). Please see Appendix A for Human Research Ethics approval letters.

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Dedication

To the loved one's I have lost along the way, may you rest in peace.

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List of Abbreviations

AF	Australian football
AFL	Australian Football League
ASE-Model	attitude-social influence-self efficacy model
BSSTM	behavioural and social sciences theories and models
DIT	diffusion of innovations theory
HBM	health belief model
LLI/s	lower limb injury/injuries
LLIP	lower limb injury prevention
PAFIX	Preventing Australian Football Injuries through eXercise
PBC	perceived behavioural control
PPE	personal protective equipment
SCT	social cognitive theory
SET	specialised exercise training
SIP	sport injury prevention
TPB	theory of planned behaviour
TRA	theory of reasoned action

Preface

Structure of the Thesis

This thesis research comprises six sections and fourteen chapters. Figure 1 outlines the structure of the thesis and is followed by a summary description of each section/chapter.

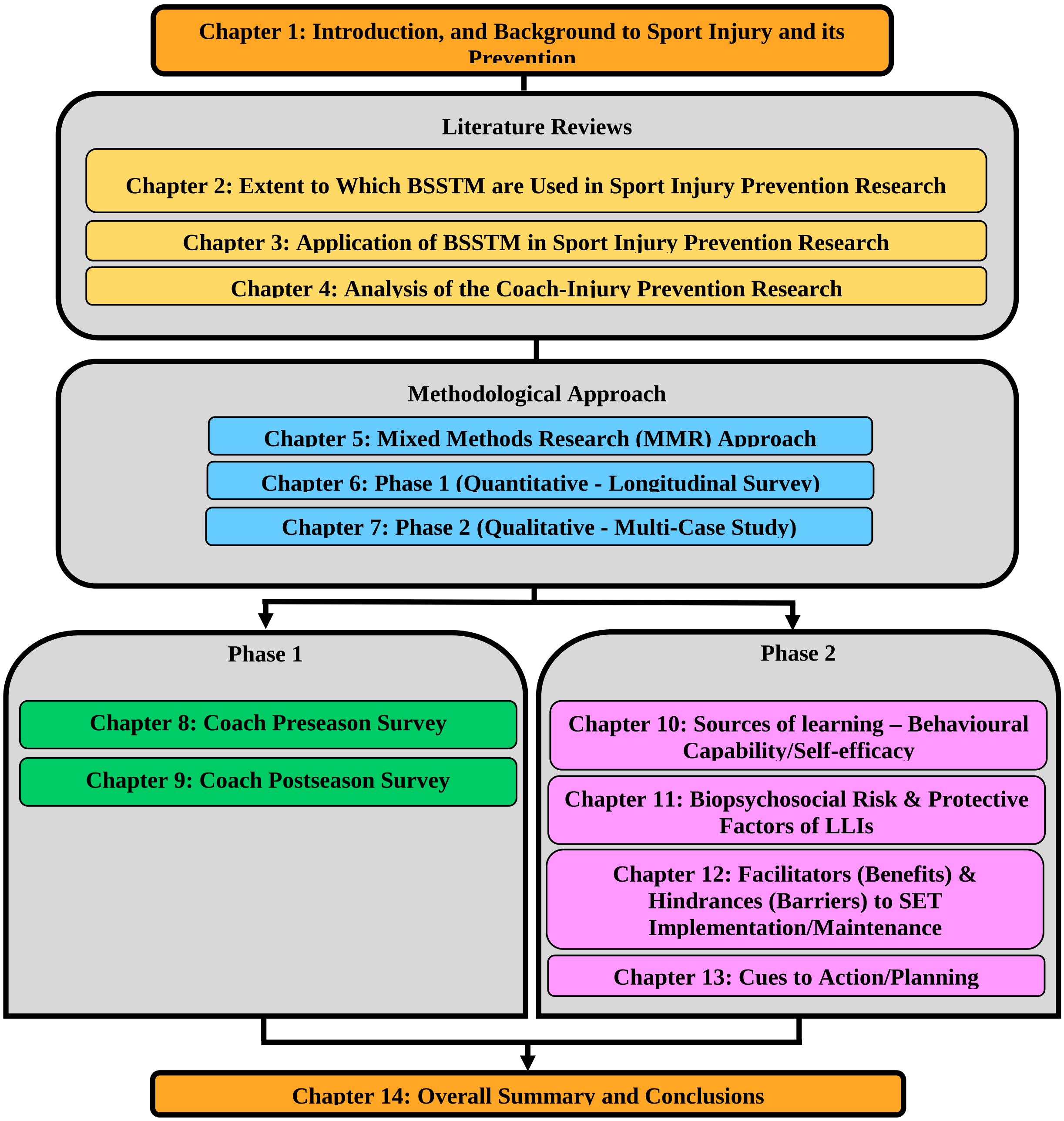

Figure 1. Outline of thesis structure.

The introductory chapter provides a general background and rationale for this thesis research, and briefly reviews the literature pertinent to the topic of sport injury prevention research (SIP), particularly focusing on LLI prevention in CAF. It provides evidence of sport injury as a public health issue, epidemiology of injuries (including LLIs), risk factor and aetiology of LLIs, current prevention measures, and gaps and limitations of existing research overall. The chapter highlights the lack of focus on behavioural approaches in Australian Football (AF) and sport injury prevention research in general, providing an impetus for the focus of this thesis research. The importance of using BSSTM, in particular, to help understand the determinants of SET behaviours and improve the implementation of evidence-based research and practice amongst coaches in CAF contexts is underscored. Finally, the overall purpose, aims, research questions, methodology and the significance of this thesis research are outlined.

Section 2 is focused on bringing together detailed reviews and descriptions of the extent and nature of the most common BSSTM and their application to understanding SIP behaviours in a range of sport contexts. It helps builds the case for integrating BSSTM to understand SIP behaviours, and the importance of exploring coaches' roles—their cognitions and behaviours—in devising behaviour change and implementation strategies to support optimal adoption and maintenance of SET interventions. Chapter 2 provides a substantive systematic review in addressing the extent to which BSSTM have been used in sport injury prevention research. Chapter 3 describes in detail the most common and widely applied BSSTM identified in Chapter 2, and critiques themes and issues in the use of BSSTM in understanding behaviour change processes that may underlie intervention effectiveness and of applying this knowledge to inform the design of future SIP interventions. The chapter outlines in a sequential manner the background to and origins of a given BSSTM; followed by a description of the BSSTM, its components and evidence for its use (advantages/disadvantages); and a summary and critique of the applicable research paper/s in sport injury prevention (Chapter 2) using the BSSTM. The chapter concludes with an overview of BSSTM applied in sport injury prevention research and a discussion of cross-cutting themes, challenges and unresolved issues, and future directions. The final chapter in this section, adopts a systematic scoping review approach to analyse the coach-specific research in sport injury prevention, which was identified in Chapter 2 to be a largely unexplored topic focus in sport injury prevention research. It extends Chapters 2 and 3, as an emerging area of research and provides an updated and in-depth analysis of the coach literature, and recommendations for future applied research. To conclude the section, a summary that highlights the gaps in the literature and demonstrates the need for this thesis research is provided. In the context of this thesis, these reviews collectively are an essential component of evidence-based practice, and were of primary importance in shaping and informing the study design, and direction of the thesis research described in subsequent chapters.

Section 3 presents the methodological principles underpinning this thesis research, and comprises Chapters 5-7. Chapter 5 provides an outline of the mixed methods research approach (MMRA) applied to a longitudinal survey design within a larger study in Phase 1, and follow-up multi-case studies in Phase 2. The rationale for using an MMRA and participant sampling in this research are discussed. Key features for the designs in Phase 1 and 2 are discussed in successive chapters. Chapters 6 (Phase 1—Quantitative, Longitudinal Surveys) and 7 (Phase 2—Qualitative Multi-Case Studies) provide the methodology and procedures governing the data collection, data management and analysis techniques.

The fourth and fifth sections (Phase 1 and 2, respectively) offer a series of chapters that examines and describes coaches current training behaviours and situational-contexts, their salient beliefs about factors that may or may not motivate them to make changes in their training practices, and how a coaches capacity may be enhanced to make LLIP behaviour changes and integrate SET into their coaching. Section 4 provides the findings and inter-related discussions from a longitudinal survey aligned with a larger project, and examines coaches volitional behaviours and motivational beliefs in preseason (Chapter 8) and postseason (Chapter 9) to ascertain the value of SET and how SET could be better integrated into CAF coach practices in future.

Chapter 8 examines the proportion of coaches who have implemented LLIP strategies and identifies factors influencing coaches' abilities or willingness to adopt and implement SET. This study describes coaches' characteristics/demographics, motivational processes (self-efficacy, outcome expectancies, risk perceptions), training plans, coaching goals (distal and proximal/intentions to use SET). Chapter 9 aimed to further explore and describe coach characteristics, motivational beliefs (LLI risk perceptions, outcome expectancies and self-efficacy), their generalised experiences and perceptions of SET implementation (including volitional/behaviour change techniques used by coaches), socio-structural factors and coach goals/intentions that may relate to successfully integrating and maintaining SET in their coach training practices and plans in future seasons (beyond the trial). The information obtained collectively in both chapter 8 and 9, was deemed important to assist in the planning and implementation of intervention efforts in preventing LLIs and incorporate strategies to enhance coach effectiveness in facilitating or delivering SET in their community level AF club training sessions in the future.

The fifth section explores and describes more in-depth the factors identified in Phase 1 and other coach salient beliefs not uncovered. Whether coaches continued to maintain the SET beyond the trial phase, and how SET could be more effectively integrated into coaching training plans and practices in CAF contexts was also investigated. The findings are presented in four main chapters (Chapters 10-13) and each chapter is presented with accompanying discussion, as it was thought that connections could more easily be established between the findings and the extant literature and therefore best elucidate coach salient beliefs.

Chapter 10 explores the generic experiences and development of becoming a coach, the different learning situations in which community coaches learn to coach, and preferences for learning. This was aimed to support and promote "mastery" knowledge and skills (behavioural capability/self-efficacy) for coaches to deliver LLIP programs (e.g., SET) into their training sessions. The facets of informal and formal learning and development identified by coaches can be used for conducting further research, and for devising specific strategies, and interventions to enhance and promote SET programs to prevent LLIs.

Chapter 11 explores coaches' beliefs associated with their players' chance of sustaining LLIs (perceived susceptibility), and the risk and protective factors that they believed either heightened or reduced the risk of players sustaining LLIs. This study was aimed to complement findings in Chapters 8 and 9, and advanced understanding of a broader range of factors underlying coach beliefs about their players' susceptibility to LLIs, from a biopsychosocial perspective. This chapter provides the basis for further research into risk perceptions (perceived susceptibility) and how such perceptions may influence a coach's injury prevention behaviour. It also provides some useful information about coaches' LLI beliefs and afforded the opportunity to work with coaches in an applied context in the future to support SET use, and confirm or dispel any misconceptions they have about LLI susceptibility.

Chapter 12 aimed to explore coaches' perceived facilitators (benefits) and hindrances (barriers) associated with the implementation and maintenance of SET programs in CAF training. The information identified in this chapter, assists in understanding more fully coaches' salient beliefs—facilitators and hindrances—of SET adoption and maintenance, extending findings in Chapter 8 and 9. The findings in this chapter can be used to further develop, promote and enhance the implementation and maintenance of multi-focused SET interventions in both research and applied settings in the future. Specifically, it can assist in the defining of action to take about SET and prevent LLIs (how, where, and when); clarify the positive effects of SET to be expected; and identify and reduce perceived hindrances/barriers of SET through devising collaborative strategies, providing reassurance, correction of misinformation, and provision of incentives and assistance.

Chapter 13 is the last of the findings and discussion chapters. This chapter focuses on the construct of cues to action/planning. The specific aim of this chapter was to gain coach insights about "what" strategies—and "how" they believed such strategies—could be used to activate coach "readiness" to implement and maintain SET. With a view to target the broad spectrum of CAF coaches, the information obtained from this chapter can be used to develop and test strategies for change, and promote and develop behaviour change strategies (e.g., provide how-to-information, promote awareness, and employ reminder systems) in relation to SET and the prevention of LLIs. This chapter provides additional support for strategies reported by coaches in Chapter 9 to improve the implementation of SET.

The final chapter, Chapter 14, provides a summary table of the literature review section (chapters 2-4) and overall findings and discussion chapters 8-13. The overall implications, strengths, and limitations of this thesis research are discussed and recommendations for future research are articulated.

List of Peer-reviewed Publications, Conference Abstracts and Presentations

The following are the peer reviewed publications, conference abstracts/presentations produced from this research.

Publications – Peer-Reviewed Journal

McGlashan, A.J., Finch, C.F. (2010). The extent to which behavioural and social sciences models and theories are used in sport injury prevention research, Sports Medicine, 40 (10), 841-858. [Impact Factor: 5.327; Google citations (as of 13th January 2015): 39]

Publications – Conference Abstracts/Presentations

McGlashan, A.J., & Finch, C.F. (2009) Australian football coaches' perspectives: Tackling injury prevention translation in community level Australian football. University of Ballarat Research Conference Abstract Booklet, p56.

McGlashan, A.J., & Finch, C.F., & Twomey, D.T. (2008) Are we using behavioural and social sciences theories and models in sport injury prevention research? Journal of Science and Medicine in Sport, 12, S54.

McGlashan, A.J., & Finch, C.F., Aucote, H., & Twomey, D.T. (2008) Exploring the evidence in sports injury prevention from a behavioural and social science perspective - an example of how to conduct a systematic review, University of Ballarat Research Conference Abstract Booklet, p84.

McGlashan, A.J., & Finch, C.F., & Twomey, D.T (2007). Behavioural aspects related to the adoption of safety measures in Australian football: preliminary findings, University of Ballarat Research Conference, p82.

SECTION I

Chapter 1: Introduction

1.1 Background to the Issue of Sport Injury, and its Prevention

It is widely known that physical activity and participation in sport leads to positive health and lifestyle benefits on a range of dimensions [1-6]. In light of this, the promotion of physical activity has been a major public health priority in Australia and internationally for improving the overall health of the population and reducing the overall burden of disease [2,6-9]. Concomitant with this, however, there has been, and continues to be, widespread concern about sports-related injuries [10,11]. To a large extent, the burden of sport injuries can be reduced by means of prevention, but this would require a multi-disciplinary approach [12]. To that effect, research into the most effective means of preventing injury is crucial, as is effective interpretation of the science of sports injuries and its translation into practice.

1.1.1 Sports injury: a global public health problem

Sports and recreational injuries (hereafter referred to as sports injuries) are considered a priority area for injury prevention globally, as they pose a significant public health burden on individuals and the community; they are also a major barrier toward participation in health- promoting physical activity [10,11,13-20]. Sport injuries can result in adverse consequences related to the duration and nature of treatment, the amount of sporting and working time lost, permanent damage or disability, reduced quality of life, and various monetary costs [10,17,21,22]. In Australia alone, estimates indicate that 5.2 million participants sustain sports injuries each year [23], and the annual costs of sports injury are assessed to be approximately AUS$2 billion [24]. Within the European Union, it is estimated that each year more than ten million people have a sport-related injury requiring medical attention, with a cost that exceeds more than €10 billion [25]. Other countries such as the United Kingdom, United States, Canada, and New Zealand have also noted important social and economic tolls from sports injury [19,26,27].

While there is an inherent risk in many sporting activities, most injuries are predictable and therefore preventable [10,28,29]. Accordingly, they are not “just part of the game” [14] and most can be prevented, or controlled, through implementing appropriate interventions [12,30,31].

Although there have been significant increases in knowledge about some aspects of sport injury and sport safety over the past decade [32,33], many facets remain unknown or inconsistent and the evidence base for a full range of preventive measures is largely non-existent [10,13,14,31]. To address this gap, more research is needed to develop and implement evidence-based strategies to prevent sport injuries at the population-level. Such research will provide a significant underpinning for the promotion of safer, lifelong participation in sport and physical activity, and reduce the public health burden of sport injuries.

1.1.2 Australian football injury as a public health priority

Of all sports, team ball sports are most often discussed in the literature in relation to the high incidence of sports injuries [10,23]. Among these, injuries to participants of football codes such as AF, American football, rugby league, rugby union, and soccer predominate [19,34,35]. This thesis is concerned specifically with injuries in AF.

Australian football is an integral part of the cultural fabric of Australia. It is a full-body contact sport, and represents one of the most popular Australian team sports both in terms of participation numbers [36-38] and as a spectator sport [39]. It is estimated that over 300,000 participants aged 15 years and over play AF Australia-wide [36-38]. However, the safety of AF participants has often been questioned due to its high ranking in injury statistics [20,23,35,40-43], the excess risk of injury associated with the nature of the game [44,45], and subsequent adverse sequelae of its injury outcomes [20].

Recently, AF was demonstrated to have a high rate of hospital admissions Australia-wide, with 734.3 injuries per 100,000 participants [35]. Earlier studies also indicated that AF has the highest number of presentations across a range of treatment settings in comparison with other sports [40-43].

Although treatment-based studies generally represent the more severe spectrum of injury cases, these figures highlight AF as a priority area for injury prevention.

While some preventive efforts have been developed and adopted in AF to varying degrees [46-49], there is currently a paucity of evidence-based research into the effectiveness of many intervention measures in preventing injuries in AF [44]. The current lack of evidence about their effectiveness limits the safety information and knowledge transfer into practice that can be given to AF participants, their parents and coaches, and sporting administrators [44]. Although some commentators have identified AF as a priority sport on which to focus injury prevention action and research [44], progress has been slow. Field-based studies in the real world context of AF delivery, including randomised controlled trials (RCTs) to identify injury risk factors and to evaluate the effectiveness of injury prevention strategies need to be undertaken to progress safety gains in this sport [10,44,50].

1.1.3 Epidemiology of injuries in Australian football

Injury surveillance provides epidemiological data describing the occurrence of injuries and associated risk factors. This information can be used to direct strategies designed to reduce the overall risk of injury [12,31]. To date, the data describing AF injuries comes from three major sources: (1) studies of players with specific clubs or teams, (2) studies of injuries presenting to various treatment sources, and (3) population-based surveys of community groups [51]. Due to the direct relevance to the proposed thesis study only the adult club-based studies will be described in this section (also see, [51]).

Ferguson [52] is cited as one of the first authors reporting injuries in AF. Fifteen years later (in the early 1980s) new studies examining the general injury patterns and profiles in AF appeared [53-56], with all highlighting a clear need for injury prevention in this sport. Two decades later, ongoing research into AF injuries has continued to highlight the often increasing incidence of AF injuries and their outcomes. The majority of these studies relate to the elite level of the game [52,53,56-67].

Although more footballers participate at the community level, injury studies for this level of the game have only been published relatively recently. Based on the few published studies of the non-elite level AF injuries [55,60,68-78], there is a demonstrated need for injury prevention strategies in CAF [44,79].

From a public health perspective, CAF has the largest participant base, and efforts to prevent injury are likely to have the greatest impact in this group of players. Table 1.1 summarises the adult non-elite AF descriptive epidemiology (injury surveillance) studies published to date. The few studies that have described injuries at the non-elite level have indicated that most occur during competitions, earlier in the season, mainly to mid-field players, and are muscle strains/tears to the lower limb [55,60,68,71,72,75,77,80,81].

Despite differences in methodology across studies (making direct comparisons between studies difficult), it is evident that in non-elite AF 40%–68% of all injuries occur to the lower limb region (e.g., knee, ankle, hamstring and quadriceps muscles), accounting for a markedly higher proportion of injuries in comparison to other body regions [51,55,60,68,71,72,75]. While all injuries that occur in AF are of concern due to potential adverse outcomes, injuries to the lower limb are the most common cause of time lost by participants in both training and games [55,67,68,75]. Of these, knee injuries account for 20–80% of all LLIs at the community level [55,60,68,71,72,75] and also account for more than 30% of all medically treated AF injuries [43,71,72,75]. These injuries often need surgical repair and long-term rehabilitation and can result in functional impairment and permanent disability [82,83]. For these reasons, most research to date has focused on reducing the risks associated with knee injuries (e.g., anterior cruciate ligament injuries), though LLIs in general, are still an important focus.

1.1.4 Aetiology: causes and mechanisms of knee injuries in Australian football

There is evidence to suggest that AF-related knee injuries occur during common manoeuvres such as running, jumping, landing, and sidestepping; and are predominantly non-contact in nature [84-87]; over 56% of all knee injuries occur without contact from another player [87,88]. This is also supported by research in other sports which found that more than half were from non-contact situations [89-91].

Table 1.1

Summary of non-elite club-based injury surveillance studies in Australian football

Ref.	Competition	Year/s of data collection	Place of study	Study Design/ Data Collection Method	n (players)	Overall Injury Rate (inc. both training and games exposure)
[68]	Community/ Amateur	1981	Prahran, Melbourne, Victoria	Prospective Cohort -Data collected at the time of the injury by medical officer's	58	1 every 28 man risk hours
[55]	Community	1983-1984	Bendigo, Victoria	Retrospective Cohort -Self report, survey of injuries sustained in previous season	55	148 injuires:100 players [a, e]
[60]	Amateur	1993	Victoria	Prospective Cohort -Data recorded by club doctor over 18 weeks	80	96.0 injuries:1000 player hours
[70]	Community	1999	Perth, Western Australia	Prospective Cohort -Self report, monthly telephone calls	547	20.3 injuries:1000 player hours [b*]
[72]	Amateur	1999	Melbourne, Victoria	Prospective Cohort -On-field physios, collected data at time of injury over 18 weeks (April-August)	320	27.2 injuries:1000 player hours
[71]	Community	1997-1998	Perth, Western Australia	Prospective Cohort -Self report, monthly telephone calls	547	20.1 injuries:1000 player hours [b*]
[75]	Community	2001	Melbourne, Victoria	Prospective Cohort -On-field primary data collectors, collected data at time of injury over 18 weeks	301	12.1 injuries:1000 player hours [c*]
[76]	Community	2001	Melbourne, Victoria	Prospective Cohort -On-field primary data collectors, collected data at time of injury	301	2.6 injuries: 1000 player hours [c,d*]
[77]	Community	1997-1998	Perth, Western Australia	Prospective Cohort -Self report, monthly telephone calls	535	24 injuries: 1000 player hours [b*]

a. AF injury data only (excluded soccer data)

b. Western Australia Sports Injury Study (WASIS)*

c. Australian Football Injury Prevention Program (AFIPP)*

d. head/neck/orofacial injuries only; (*Note: indicates same study -different injury data collection focus in published studies)

e. not clear if collected both training and game exposures.

Although knee injuries can have a complex multifactorial aetiology [92,93], most lab-based, cadaveric, and video analysis studies have described non-contact ligament injuries as a neuromuscular and biomechanical problem, in that ligaments fail when applied physical loads exceed tissue strength [84-87,94,95]. Thus, knee loading patterns during activities such as cutting manoeuvres (e.g., sidestepping) can place the knee at greatest risk and cause injury. As a consequence, a critical factor identified in lowering the incidence of knee joint ligament injury is a reduction in tissue loading on the knee [84-87]. Based on this evidence, biomechanical and neuromuscular SET programs have been recommended. These are aimed to target specific muscle activation strategies, to stabilise valgus and internal rotation of the knee, and possibly increase hamstring activation to oppose the quadriceps effect and increasing knee flexion angle, at foot contact [86,87].

1.1.5 Prevention of lower limb injury

Internationally over the past decade, results from the design and implementation of LLIP exercise training programs based on addressing neuromuscular and biomechanical factors for soccer, volleyball, handball and basketball have been published [96-109]. There is therefore some accumulating evidence that such specialised exercise programs, including components of proprioception-balance and plyometric-agility, can reduce the incidence of LLI. Published studies vary widely both in their design and implementation methods. The majority of studies have been non-randomised [97-102,110] and, until recently, few randomised controlled trials have been conducted [104,105,107-109,111]. A small number of recent reviews provide evidence for these RCT's and SET interventions to prevent LLIs [51,112,113].

Despite the fact that some programs have been shown to prevent LLIs, the benefit of any intervention strategy is determined not only by its efficacy and effectiveness to prevent injury, but also by the extent to which it is appropriately adopted, implemented and maintained [31]. Within the existing LLI intervention literature, implementation issues in relation to adoption and adherence of the SET programs have been cited [100,102,105,107,109,110], but in most instances are rarely, if ever, discussed. There also seems to have been little, or no, formal assessment of the determinants and influences of SET program adoption and maintenance to enhance intervention success and support the development and dissemination of LLIP interventions [107,109,111,114]. Thus, their actual effectiveness in preventing LLI is difficult to determine based on the available literature. While previous research [86] provides the rationale for SET programs to reduce the risk of knee injury in AF, there has been no published study about the effectiveness of such programs in CAF [115].

1.1.6 Implementing exercise programs for lower limb injury prevention

Translation of biomechanical evidence into real-world practice requires a clear understanding of the context—the prevailing sports culture and player behaviours; in which it will be applied or implemented [116]. As Finch [31] outlined in her translating research into injury prevention practice (TRIPP) framework, "advances in sports injury prevention will only be achieved if research efforts are directed towards understanding the implementation context for injury prevention, as well as continuing to build the evidence base for efficacy and effectiveness" (p.5).

Historically, it appears that sports injury prevention researchers have assumed that an intervention deemed efficacious in an experimental setting will easily (or often automatically) be translated to the field of practice [117,118]. Unfortunately, this is not the case. Even if measures to prevent injuries are shown to be efficacious, they will only prevent injuries and achieve a public health impact if players, coaches and sporting bodies actually adopt, use, and maintain programs over time [31,116]. There is a critical need to minimise this gap between research, practice and delivery to ensure impediments to preventing and reducing LLIs in AF do not occur. Increasing the use of more active rather than just using passive approaches seems warranted.

To progress the field, behavioural and social science considerations are important [119-121] and have the potential to provide a bridge between "technology" and the application of these advances to improve public health outcomes in sport [121,122]. Their application offers relatively new opportunities [119] to understand the diverse psychosocial, socio-cultural and behavioural determinants that could explain injury prevention-related behaviours among all involved in sport, for example, AF players, coaches and administrators. This in turn, can assist in identifying mechanisms of change, determine why programs succeed or fail, and provide guidance for building more effective prevention programs [121].

In the last decade there have been only been a few studies that have been conducted in AF relevant to behaviour change approaches regarding the use of safety measures overall. The studies that have been conducted have focused on the general safety attitudes and beliefs of junior AF players [123], attitudes of CAF players toward protective headgear and the risk of head injury [73], CAF players' attitudes toward protective headgear and mouthguards [75], knowledge, attitudes, and behaviours of coaches towards LLIP in semi-elite AF [124], and more recently, coach attitudes about concussion guidelines [125,126]. See Table 1.2.

Collectively, these studies form a growing body of evidence indicating that players and coaches beliefs are important in promoting and preventing a wide range of sport injuries to facilitate reductions in injury and improve sport participation and performance outcomes [127]. However, very few of these studies have used behaviour change theory to better understand player and coach beliefs [123,125,126] and how safety measures could best be implemented into their sport environments. This gap in the use of behaviour change theory to understand both player and coaches beliefs and devise behaviour change strategies accordingly is important, and will be explored further in Section II as a major component of evidenced-based practice underpinning this thesis research.

Table 1.2

Summary of the behavioural-based research in Australian Football

Ref.	Year published	Competition/ level	Location	N	Preventive measure/ Injury	Theory
[123]	2002	Junior/ Elite	Victoria, Australia	103 players	PPE-General	Yes, TRA/ TPB
[73]	2003	Adult/ Amateur/ Community	Victoria, Australia	70 players	PPE-headgear; head injury	No, atheoretical
[75]	2004	Adult/ Community	Victoria, Australia	301 players	PPE-headgear and mouthguards; head/ mouth injury	No, atheoretical
[124]	2008	Community/ Amateur	NSW, Australia	9 coaches	SET-General LLIs	No, atheoretical
[125] [a]	2013	Adult/ Community	Australia-wide	183 coaches	Concussion Guidelines	Yes, extended TPB
[128] [b]	2014	Adult/ Community	Australia-wide	260 coaches	Concussion Guidelines	No, atheoretical

Note: a. study included other participants - Australian football n=121 sports trainers; Rugby league n=171 coaches, n=142 sport trainers

Note: b. study included other participants - Australian football n=161 sports trainers; Rugby league n=267 coaches, n=228 sport trainers

1.1.7 Developing exercise training programs with community coaches

Although several studies have examined player attitudes towards a range of safety measures (including general safety measures, personal protective equipment - headgear, mouthguards, faceguards) in the extant literature [127], relatively fewer studies have explored coaches beliefs or how they might integrate prevention programs into their coaching practices [127] (see Section II; Chapter 4).

One study examined semi-elite AF coaches beliefs and volitional behaviours and found that football training sessions did not give enough attention to the development of skills needed to prevent LLI, citing a lack of content information and practical training resources [124]. Other researchers have found similar findings, demonstrating how a lack of knowledge of sport prevention intiatives and other determinants results in inconsistencies in their application (see Chapter 4). It is known in the general coaching research that coaches prefer to receive information to support their coaching practice in more user-friendly hands-on activities as well as coaching opportunities that offer support from mentors/consultants. However, there has been a very limited number of interventions developed or evaluated to promote coaches use of prevention measures [111,128,129], and specficially none to promote the integration of SET to prevent LLIs in CAF. This is a concern because coaches have an influencial role in facilitating training for their players. If appropriately tailored cognitive and behavioural interventions (e.g., education seminars, goal-setting [130], mentors/consultants, psychological skills training/imagery [131], reflective practice, motivational interviewing) aligned with specialised LLI exercise prescription are not accessible, coaches are not likely to be motivated or confident in their abilities to integrate SET in their training practices. Therefore, obtaining a better understanding of the nature of CAF coaching practices and beliefs that may influence coaches effectively integrating and maintaining SET into their training practices over the longer term is needed to advance this key public health area of interest. This is consequently a key emphasis in this thesis.

1.2 Research Aim, Objectives and Research Questions

Based on the research evidence, SET programs integrated into coaching practices are needed to prevent LLIs, however the beliefs of CAF coaches should be included into prevention programs in order to increase their integration and effectiveness (adoption and maintenance). A range of coach interventions (e.g., offering practical workshops and consultant support) are needed to be developed because they have the potential to help increase coaches motivations, interpersonal capabilities and confidence in planning and implementing SET to reduce LLIs for their players.

Herein, the **overall aim** of the current research was to:

Apply a range of BSSTM, to help better understand the contextual and specific nature of coach behaviours and salient-beliefs, in order to devise a range of behaviour change strategies and interventions to effectively support coaches integrate SET into their coaching practice in the future, as part of wider injury prevention efforts.

The research had three primary objectives:

Objective 1

- To understand the extent and nature to which BSSTM has been used in sport injury prevention research to support evidence-based research and practice.
- To analyse the current state of coach-injury prevention research to identify exisiting gaps and inform future research and practice.

Objective 2

- To apply a combination of BSSTM as a means of developing a greater understanding of the contextual and specific nature of CAF coach behaviours and beliefs in order to devise approporiate behaviour change strategies to effectively integrate SET in the future.

Objective 3

- Overall, to provide a contribution to the existing literature related to the application of BSSTM in sport injury prevention, the role of the coach in sport injury prevention, and the human movement and sport sciences scholarship in an Australian context.

One central research questions directed the research process:

What is the contextual and specific nature of CAF coaching practices and coach motivational beliefs associated with intergrating SET to prevent LLIs?

The above question formed a starting point for the research with subsequent focus areas to support the research process in Phase 1 and Phase 2. Based on the application of BSSTM and/or constructs. Table 1.3 and 1.4 provides an overview of the research questions specific to each of the 6 interlinked chapters.

Table 1.3

Summary of studies in Phase 1 with reference to chapter number, application of theory or construct, and research question(s)

Chapter	**Theory/construct**	**Research question/(s)**
8	SCT, used in conjunction with HBM Stage-Initiation/Adoption	At Preseason: 1. What are coaches current volitional training behaviours (including session and season training plans, coaching goals for the season and longer-term, common training principles, and LLIP strategies) and how prevalent are their use? 2. What are coaches current salient beliefs (risk perceptions, self-efficacy and outcome expectations) and what factors might help motivate or hinder coaches to initiate/adopt SET into their teams training sessions?
9	SCT, used in conjunction with HBM, TPB Stage- Maintenance	At Postseason: 1. Do coaches have intentions to maintain SET in future seasons? 2. What are coaches current salient beliefs (risk perceptions, self-efficacy/expectations and outcome expectancies)? 3. What are coaches generalised evaluations and experiences of the exercise trainer-led SET trial implementation (including volitional behaviour change techniques used by coaches)? 4. What were coaches vicarious experiences (during the SET trial)? 5. What socio-structural factors facilitated or hindered the SET implementation? 6. How can changes be made to SET implementation to improve its effectiveness and adoption and maintenance in the future?

Note: SCT = social cognitive theory; HBM = health belief model (perceived susceptibility/perceived severity); TRA/TPB = theory of planned behaviour/theory of reasoned action (aligned with outcome expectancies/attitudes and subjective norms and self-efficacy/perceived behavioural control)

Table 1.4

Summary of studies in Phase 2 with reference to chapter number, application of theory or construct, and research question(s)

Chapter	**Theory/construct**	**Research question/(s)**
10	Behavioural capability/Self-efficacy	1. How do CAF coaches learn to coach? 2. What are coaches preferred learning sources? 3. What are the factors that are helping/hindering coach learning and development?
11	Perceived susceptibility	1. What are coaches' perceptions of players' susceptibility to injury, in general? 2. What are the factors that coaches perceive to lower or heighten the risk for players' LLI? 3. Are coaches' risk/threat perceptions consistent with research evidence, and are there other factors (or misconceptions) that have not been considered by the coaches that could be useful to include in future coach education and other prevention interventions?
12	Perceived facilitators *(benefits)* and perceived hindrances *(barriers)*	1. What are coaches' perceived facilitators (or benefits) and hindrances (or barriers) associated with the implementation and maintenance of SET? 2. How do coaches perceive they can overcome barriers and enhance benefits of delivering SET in their own training practices/sessions? 3. What recommendations in planning future interventions and strategies can be made to enhance benefits and overcome potential barriers?
13	Cues to action/Action planning	1. How can SET be widely disseminated to support the needs of community level AF coaches and significant others over time? 2. How do coaches' views compare to the existing evidence-base, theories, or community-level strategies used in other injury prevention and other areas?

1.3 Methodology and Conceptual Framework

1.3.1 Context

1.3.1.1 Preventing Australian football injuries through exercise (PAFIX) project

As mentioned previously in this chapter, policies and strategies have been developed to create the opportunity for safe, healthy and sustainable sporting environments. However, the impact of these strategies and recommendations in many cases is unidentified.

In 2007 and 2008, the University of Ballarat (now known as Federation University Australia) in conjunction with the University of Western Australia introduced the *Preventing Australian Football Injuries through eXercise (PAFIX) trial intervention* in two Australian states of Victoria and Western Australia. The trial reflected and supported recommended initatives aimed at addressing sports injuries as a significant public health issue, and ensuring safe and sustainable participation and performance in sport and physical activity can be achieved. The premise behind the trial in CAF was that most players undertake bi-weekly training sessions to prepare for their weekend games. These sessions focus on team tactics, technique modification to enhance game skills, drills and fitness (aerobic, anaerobic and muscular endurance). However, these training programs do not typically focus on specific exercises to reduce the risk of injury, and injury is a concern in the CAF context and a priorirty public health issue.

The PAFIX trial aimed to:

(1) reduce the number of AF-related knee injuries using appropriate intervention strategies;

(2) determine the most appropriate exercise training intervention for injury reduction benefits; and

(3) understand the underlying neural and biomechanical adaptation to the intervention strategies.

1.3.1.2 Development of SET Programs

For the trial, two types of SET programs were incorporated into regular training schedules of 40 CAF teams, over two consecutive seasons (2007 and 2008). The programs were both periodised over

26 weeks and included general preparation training, basic/aggressive training and maintenance phases. The two programs were designed to take place during the warm-up period of the training sessions, for approximately 20 min; as such their intensity was purposely designed not to be overly strenuous. Prior to conduct of these training programs, players undertook a general warm-up including light running and stretching activities.

Trained undergraduate sport science students (referred to as exercise trainers) were employed under the larger project to deliver the PAFIX trial in clubs. The role of the exercise trainers was to ensure the training intervention was run in cooperation with the team coaches, and to ensure players adhered and progressed to more advanced training tasks as they become more competent and capable of performing the prescribed exercises. The project managers were available throughout the season to support the exercise trainers as well as to be a support for the participating clubs.

A brief description of the development of each program is provided as follows (for full program exercises and description for both SET programs 1 and 2, see Appendix B):

SET Program 1

The evidence-base for SET Program 1 aligned with the Translating Research into Prevention Practice framework, which states that a firm understanding of injury mechanisms is first required, and subsequent experimental evidence on countering any identified mechanisms should be used to guide potential injury prevention measures. It was based on the then available scientific literature directly pertaining to ACL injuries in AF, but also borrowed from a range of ACL injury studies pertaining to other sporting codes. This experimental evidence came from a range of different types of investigations that included cadaveric-based research, computational models, analyses of videos of in-game ACL injuries, laboratory experiments of the manoeuvres that cause injury, which were supported by interventions that tested the effect of exercise/ neuromuscular training programmes on ACL injury prevention. Specifically, SET Program 1 was designed to: fit within the real-world time confines of CAF training sessions; improve sidestepping and/or single-leg landing technique in order to lower flexion, valgus and internal rotation moments at the knee; and increase muscular support of the knee. The program incorporated balance, plyometric and technique activities. The program aimed to ensure that correct technique was utilised during both sidestep cutting and landing movements. Plyometric and balance training were used to improve stability and control of whole body movements to reduce the valgus and internal rotation moments at the knee and increase the muscular support of these moments through both an increase in strength and co-contraction of muscles. Even in the plyometric and balance training, players were instructed to keep their torso upright, to increase knee flexion with knee-over-toe postures. All of the balance, plyometric and technique elements were deemed to be the guiding principles of SET Program 1. Specifically for sidestepping, the aim was to achieve an upright forward facing torso with close foot placement, and increased knee flexion with a knee-over-toe posture. For landing, the players were instructed to keep their torso upright and to increase knee flexion.

In total, there were 20 exercises used throughout the season of four broad types: balance, basic movement, COD/agility and landing/mini-tramp activities. The program included some progressions whereby the intensity and difficulty of the program varied, beginning with less strenuous tasks and progressing in difficulty. A prime focus was on getting the players to perform the required exercises correctly and on eliciting desired neuromuscular and biomechanical changes. For each exercise, key instructional points were emphasised by exercise trainers, who were trained by project staff in how to deliver the training programs. Key points were made specific to the exercise tasks and included cues from the exercise trainers to achieve the desired techniques: avoid extraneous limb movement; concentrate on balance not the task; do not lean excessively with the trunk; keep the arms close to body; keep the contact foot in line with hips; maintain balance after task; maintain leg (shank) stability. These points often overlapped across exercises and built on each other throughout the season.

SET Program 2

The SET Program 2 was designed with the primary goal of simulating common training exercises used in CAF. This focused on drills for running, jumping, landing, change of direction (COD) and agility. The difficulty of the exercises was graduated so that their demands increased over the season. Instruction on landing, agility or change-of-direction technique and balance tasks were not included in this program.

1.3.1.3 Management of the PAFIX trial

Briefly, the PAFIX intervention trial was a two arm group-clustered RCT conducted in community Australian football during the 2007 and 2008 playing season. Eighteeen clubs from two Australian states (Victoria and Western Australia) nominated 40 teams and these groups of players were randomised to one of two intervention arms (Program 1 and 2). The recruitment phase was conducted between November and January prior to the PAFIX trial being implemented into clubs training sessions. An initial meeting was conducted with presidents and coaches of respective clubs and PAFIX project managers, who provided a powerpoint presentation of the program, written information about the program, and an opportunity to discuss the program in further detail. The information package provided to the clubs is in Appendix C. Some of the benefits and expectations of clubs participating are documented as follows below.

Benefits (resources) provided included:

- Warm up trainer for the season free of charge
- An extra support staff, free of charge, to assit the training session and games throughout the season
- Full training instruction manual
- Opportunity for you/your team to contribute to the ongoing development of the game
- Access to the latest scientific knowledge before other teams

- Partnering with Australia's leading football research team
- Regular update on project progress and other football research update
- Summary of your teams exposure, injuries and performance at the end of the season
- Report of study findings
- Access to equipment used on the completion of the project

Expectations of participating clubs included:

- Nomination to be part of the project
- Support for the project staff in the implementation of the full program, and fitness assessments
- Provide encouragement for the players to comply with the exercise program
- Allow project staff to do the warm-up section of the training sessions
- Arrange someone to supply the data collector with the team list at the match game week and post match statistics
- Facilitate the testing of key performance measurements taken on two occasions between February and August

Overall, 1564 players were progressively recruited into the trial from 8-week preseason until week 5 of the regular playing season across the two playing seasons.

Injury surveillance and detailed monitoring of exposure and intervention compliance was undertaken and a questionnaire of player and coach behaviours and beliefs completed in preseason and postseason. This thesis included an exploration of coach behaviours and beliefs only, due to the integral role coaches play in usual development and delivering of training. It should be highlighted however that I assessed the integration/effectiveness of SET as delivered in context, and not necessarily the SET (Programs 1 and 2) themselves. Setting variant research has been described as an important component of program evaluation and is particularly relevant for my thesis research, given the uncontrolled delivery of information from coaches to their teams [270,271,500]. Further details about the wider-PAFIX project are published elsewhere [115]. Additional details about the coach questionnaires, sampling procedures are provided in Section III, Chapters 5-6.

1.3.2 Using mixed methods to understand determinants of coach LLIP behaviour

This research used a mixed methods research approach (MMRA) to gain a full understanding of the research objectives of this study. Figure 1.1 shows an overview of the MMRA used in this research. Firstly, a longitudinal survey design linked to the larger PAFIX project was used in Phase 1, and included a detailed development and administration of questionnaire tools with subsequent analysis of data. The aim of this Phase 1 was to gain a better understanding of the contextual and nature of coaching (training) behaviours and motivational beliefs in preseason and postseason, both before and after the PAFIX intervention trial was implemented into the field. The postseason questionnaire also included additional measures to extend the framework adopted in the preseason to give consideration to other salient beliefs that may account for better understanding coaches' integrating and maintaining SET into their coaching practices in future seasons, above that explained by the beliefs explored in the preseason questionnaire.

Secondly, in Phase 2, a collective (multi) case study was completed, which included in-depth interviews with three coaches from three different CAF clubs, within 12-18 months following the implementation of the PAFIX intervention trial. All coaches interviewed were from clubs that participated in the PAFIX intervention trial. This second phase aimed at gaining a deeper understanding of the context of coaches training behaviours and motivational beliefs identified in Phase 1, in addition to understanding other broader determinants from the perspectives and experiences of coaches within CAF context. The data was collected, interpreted and analysed within the context of a range of BSSTM, and triangulated with the questionnaires in Phase 1, document analysis/research literature and I (researcher's) reflective journal. The methodology is described more fully in Section III.

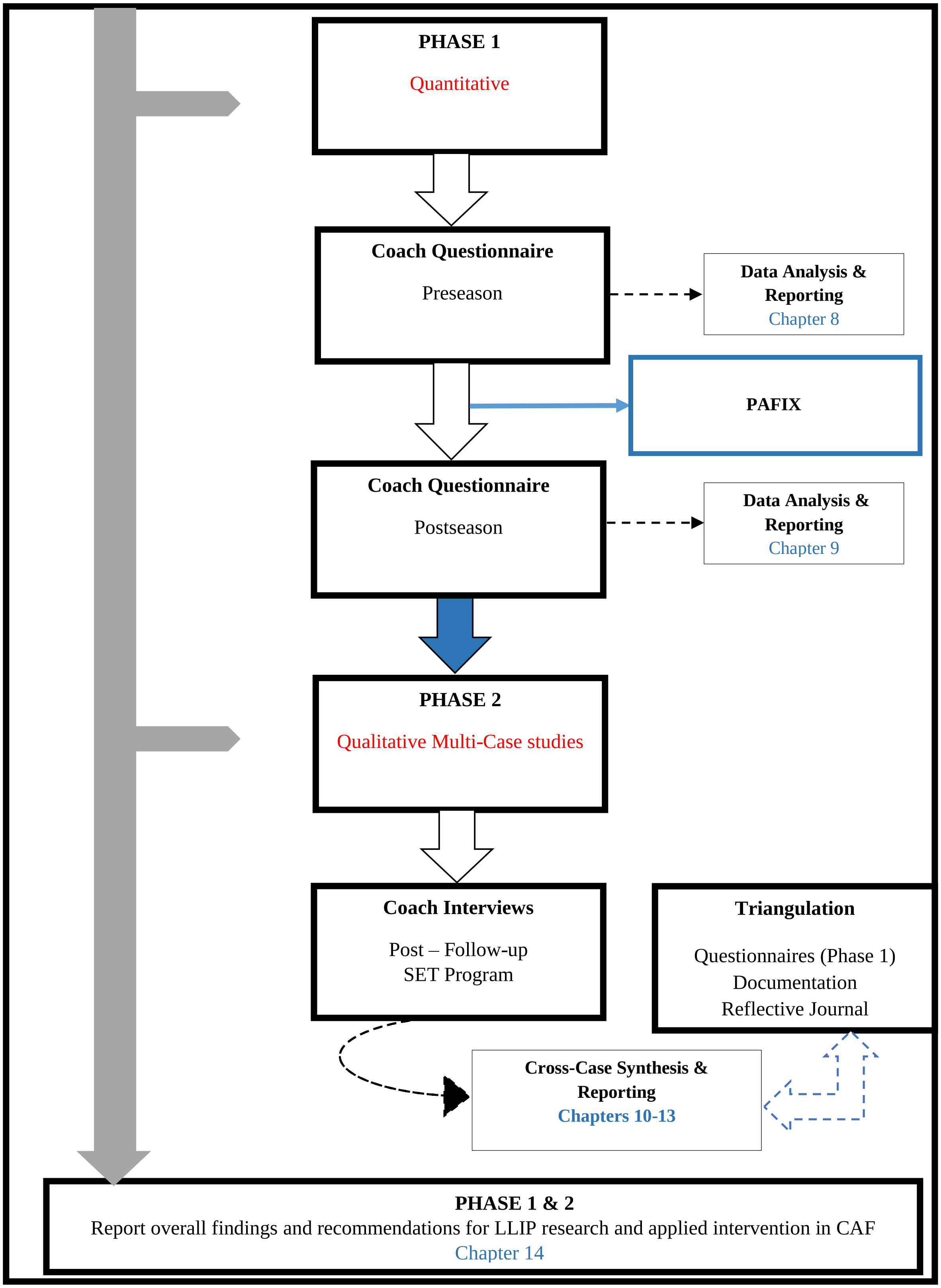

Figure 1.1. Overview of mixed methods research approach.

1.4 Significance and Contribution of the Research

Sport injury is a serious and pervasive public health concern [10]. Efforts to prevent sport injury, however, have been hindered by a lack of evidence supporting currently advocated safety measures [10].

Australian football is a popular sport, ranking as the number one organised team sport participated in by males in Australia [36]. Unfortunately, it also ranks highly in the injury statistics [20,23,35]. While much of the epidemiological evidence exists at the elite level of AF, relatively few studies have been conducted at the non-elite level, and efforts to prevent injuries are needed [44,51].

The most common injuries tend to occur in the lower limb region with knee injuries accounting for the highest proportion [51,71,72,75]. Specialised biomechanical and neuromuscular exercises have been proposed as measures to prevent LLI [86]. However, the effectiveness of these preventive measures has yet to be formally demonstrated in the field and this limits current broad recommendations for their use [86,115].

It is known that advances in sports injury prevention will only be achieved if research efforts are directed toward understanding the implementation context for injury prevention [31,116]. Thus, it is pertinent to ask what is known about preventing injury and how that knowledge can be translated into safety action. A narrow focus on particular kinds of evidence is considered one of the impediments to transfer from evidenced-based research to evidenced-informed practice [116]. Published studies frequently fail to describe implementation processes, uptake and sustainability of programs [109,110]. They are unlikely to reflect the challenges of real-world implementation and do not provide adequate evidence about effective approaches to the implementation of proven interventions. Application of behavioural and social sciences to SIP can pave the way to ensuring this happens and enhance the potential of SIP interventions to be adopted and maintained over time [121,127].

Successful behaviour change has been based on an understanding of various BSSTM [121,132], that have been used to predict and explain safety behaviour in other areas [121]. However, there is a paucity of the use of such theories in the prevention of sport injury [127] (Chapter 2-4). In addition, there are no guidelines for how to accomplish uptake and maintenance of safety measures using theories and models to build behavioural interventions. The need for a cognitive-behavioural approach has been suggested in other areas, and needs to be incorporated into the SIP research [121,127,133,134].

Overall, this research provides a new understanding of the complexity of the nature of coaching and their beliefs pertaining to enhance the effectiveness of SET into their coach training practice in future. It (1) advances theory development and application; (2) identifies salient-beliefs that may be subsequently measured through the development of a new instrument; and (3) generates new information of applied relevance and usefulness towards the potential role of coaches, their development, and how to best work with coaches (in collaboration with key others) to support and maximise the integration of SET injury prevention interventions into coaching practices over the longer term.

The use of BSSTM in this research, advances a major limitation of existing sport injury prevention research, and can be used not only to extend theoretical and methodological developments, but also to inform future evidence-based strategies concerning how interventions could be developed and disseminated to CAF clubs.

1.5 Conclusion

Coaching plays an important role in the development and participation levels of players at the community level of AF. Over the last decade there has been considerable research indicating that LLIs are a major problem and efforts have been devoted to developing prevention measures. Most of the measures or interventions that have been developed to date are based on biomechanical and neuromuscular approaches, without explicit consideration for the importance of the role of behaviour change, and more specifically the role of coaches, their perceptions of prevention programs and how they can facilitate change. In more recent times, there has been greater attention focused on why and how such prevention measures are adopted, implemented, maintained, or disseminated in order to enhance their effectiveness and outcomes. It is clear the importance of the coach's role needs to be considered alongside other imperatives of advancements in sport injury prevention research and practice.

The next section examines the pertinent literature in relation to sport injury prevention research, and provides scoping and a critical appraisal of existing research.

SECTION II: LITERATURE REVIEWS

Chapter 2: The Extent to Which Behavioural and Social Science Theories and Models are Used in Sport Injury Prevention Research

This chapter presents a word-version of the published systematic review entitled "The extent to which behavioural and social science theories and models are used in sport injury prevention research". The format and reference style of the published review was modified in this chapter to suit the conventions of the entire thesis.

The manuscript was published in the peer reviewed journal Sports Medicine in 2010. Appendix D contains the published version of the manuscript (including the supplemental digital content, containing the appendix as referred to in the full version of the manuscript). The publication details are:

McGlashan, A.J., & Finch, C.F. (2010). The extent to which behavioural and social science theories and models are used in sport injury prevention research. Sports Medicine, 40 (10), 841-858.

This substantive systematic review presents and summaries the extent to which the use of BSSTM has been reported across a range of sports injury prevention studies as a precursor to better understanding intervention effectiveness. In doing so, it identifies which BSSTM have been most commonly used to date and categorises the theoretical contexts in which they have been applied.

2.1 Introduction

There has been, and continues to be, widespread concern about sport and recreational (hereafter referred to as sport) injury worldwide [10,11,13,14,17-20]. Prevention of sport injuries is a complex process because of the multi-factorial nature of their causes and risk factors [29,135]. Accordingly, a multidimensional approach is required to address the problem and this must be implemented within the context of the prevailing sports culture and player behaviours [31,116,136]. Although a range of injury prevention measures have been evaluated within sport [117,137], a lack of rigorous, directed behavioural and social sciences research into sport injury prevention, either in isolation or in combination with other approaches, has been suggested as contributing to difficulties in achieving uptake and dissemination of effective preventive measures [31,122,138]. While there has been increasing attention directed at establishing the efficacy of many and varied sport injury measures or interventions to prevent injury, much less attention has been given to the development of, and research into, effective methods for broader uptake, dissemination and diffusion of interventions in this context [31,116,139].

A recent systematic review [122] has emphasised the lack of BSSTM being applied to unintentional injury prevention in general. These authors noted the paradox that while integration of BSSTM in other health research areas has grown significantly over recent years, it does not yet appear to have been adopted widely by injury prevention researchers [122]. Several other publications in the general injury prevention area have also emphasised the need to integrate BSSTM with the development of injury interventions [121,140-142]. More recently, in the context of sport, Finch [31] highlighted research into this area as a key knowledge requisite in her Translating Research into Injury Prevention Practice (TRIPP) framework.

The importance of BSSTM is that they can provide tools for moving beyond intuition about what might work, or efficacious evidence from controlled trials, to the design and evaluation of interventions requiring adoption and maintenance of safety behaviours in the real world. They do this by providing a theoretical and conceptual basis for understanding safety behaviours and their determinants [119,121,132,143], thereby presenting a systematic way of better understanding the events or situations that can explain or predict injury events, as well as the relationships between them [132]. Models draw on a number of theories to help understand a particular problem in a certain setting or context [132], as, for example, was recently applied to understand protective eyewear behaviours in squash players [143].

Using BSSTM as a foundation for the development of interventions and planning for their delivery is consistent with the rationale for broader-based evidence-based interventions in public health and behavioural medicine [119,121,132]. Use of behavioural theory, in particular, provides a framework for studying problems, identifying target groups and behaviours for intervention, developing appropriate interventions, measuring change in relevant behaviours and for evaluating intervention success [121]. In turn, this can lead to greater insights for programme planners and implementers to translate stronger programmes with higher uptake. Considerations from BSSTM framed within an ecological framework contribute to this by explaining the dynamics of safety behaviours, including processes for changing them and both the positive and negative influencing factors associated with both social and physical environments [143]. It has been argued that intervention programme planning, implementation, and evaluation processes based on BSSTM are more likely to succeed than those developed without the benefit of a theoretical perspective [121,144].

As these approaches work for general public health and other safety initiatives, it would seem likely that they would also make a significant contribution to the prevention of sports injuries [143,145]. Although a number of recent systematic reviews of sport injury prevention measures shown to be efficacious have been reported [117,118,137,146-149], none have described the role of BSSTM in the reviewed interventions, even though almost all interventions trialled to date have required some form of behaviour change on the part of a player, athlete or coach. In contrast, there is a major knowledge gap in relation to the effectiveness, or real-world uptake, of sports injury prevention interventions. This paper reviews and summarises the extent to which use of BSSTM has been reported across a range of sports injury prevention studies, as a precursor to better understanding intervention effectiveness. In doing so, it identifies which BSSTM have been most commonly used to date and categorises the theoretical contexts in which they have been applied.

2.2 Methods

2.2.1 Search and selection strategies

A comprehensive electronic database search strategy was developed to identify relevant published literature associated with BSSTM and sport injury prevention from the following 24 somewhat overlapping electronic databases: 'Academic Search Premium', 'AUSPORT', 'AUSPORTMed', 'Health Science Consumer', 'Health Source: Nursing', 'SportsDiscus® with full text', 'SpringerLink', 'Web of Science', 'Web of Knowledge', 'JSTOR', 'PsychArticles', 'PsycINFO', 'Psychology + Behaviour', 'Psychoanalytic Electronic Publishing (PEP)', 'CINAHL Plus with text', 'Meditext', 'Wiley Interscience', 'APA-FT', 'PubMed', 'BMJ Journals Online', 'Electronic Journals (EBSCO)', 'Science Direct', 'Informaworld' and 'MEDLINE'. The search covered all items in each database (including 'in press' items) from the earliest records available until July 2009.

An initial broad search filter was completed using three keywords: 'sport', 'injury' and 'prevention'. Initial searches combined this injury filter with keywords reflecting BSSTM including the names of common BSSTM (e.g. Health Belief Model) identified from the broader injury prevention, health behaviour and health promotion literature [119,121,132,150,151]. The search was further refined and expanded to capture other potential studies through the use of specific keywords (in isolation or in combination) chosen as relating to the following: (i) BSSTM constructs – 'attitude', 'perceptions', 'social norms', 'perceived behavioural control', 'perceived severity/susceptibility', 'barriers', 'knowledge', 'self-efficacy', 'behavioural capability', 'reinforcement', 'environment', 'empowerment', 'motivation', 'antecedents', 'behaviour', 'adoption', 'maintenance', 'implementation', 'intrapersonal/interpersonal', 'organizational/community'; (ii) common sports injury prevention measures – ‘protective equipment’, ‘mouthguards’ ‘headgear’, ‘eyewear’, ‘faceguards’, ‘warm-up’, ‘education’, ‘training’, ‘exercises (including biomechanical and neuromuscular)’; (iii) specific sports activities – ‘football’, ‘hockey’, ‘soccer’, ‘rugby’, ‘squash’, ‘netball’, ‘basketball’, ‘tennis’, ‘volleyball’, ‘handball’, ‘baseball’, ‘softball’, ‘athletics’, ‘badminton’, excluding cycling/bicycling; and (iv) terms – ‘survey/ questionnaires’, because these are commonly used tools in BSSTM studies. The Cochrane Database of Systematic Reviews (www.cochrane.org) was also checked to ensure that no similar review was in existence there.

Figure 2.1 summarises the systematic process underpinning the review search strategy and the numbers of relevant papers identified and retained at each stage. In the initial stage, all potential articles were identified upon a preliminary review of titles, abstracts and keywords screened according to the defined broad search criteria. All duplicate articles were removed. Any study not exactly matching the stated exclusion criteria was kept for further full text review. Hand searching of the reference lists, individual journals, and identified review papers was undertaken to identify any further relevant studies not retrieved via the initial database searches. An author and citation search was also conducted to identify further studies undertaken by authors of the retained studies. The final studies identified for more detailed review were assessed against a checklist of specified inclusion/exclusion criteria. (see Appendix 1 in the Supplemental Digital Content 1, for excluded studies http://links.adisonline.com/sportsmedicine).

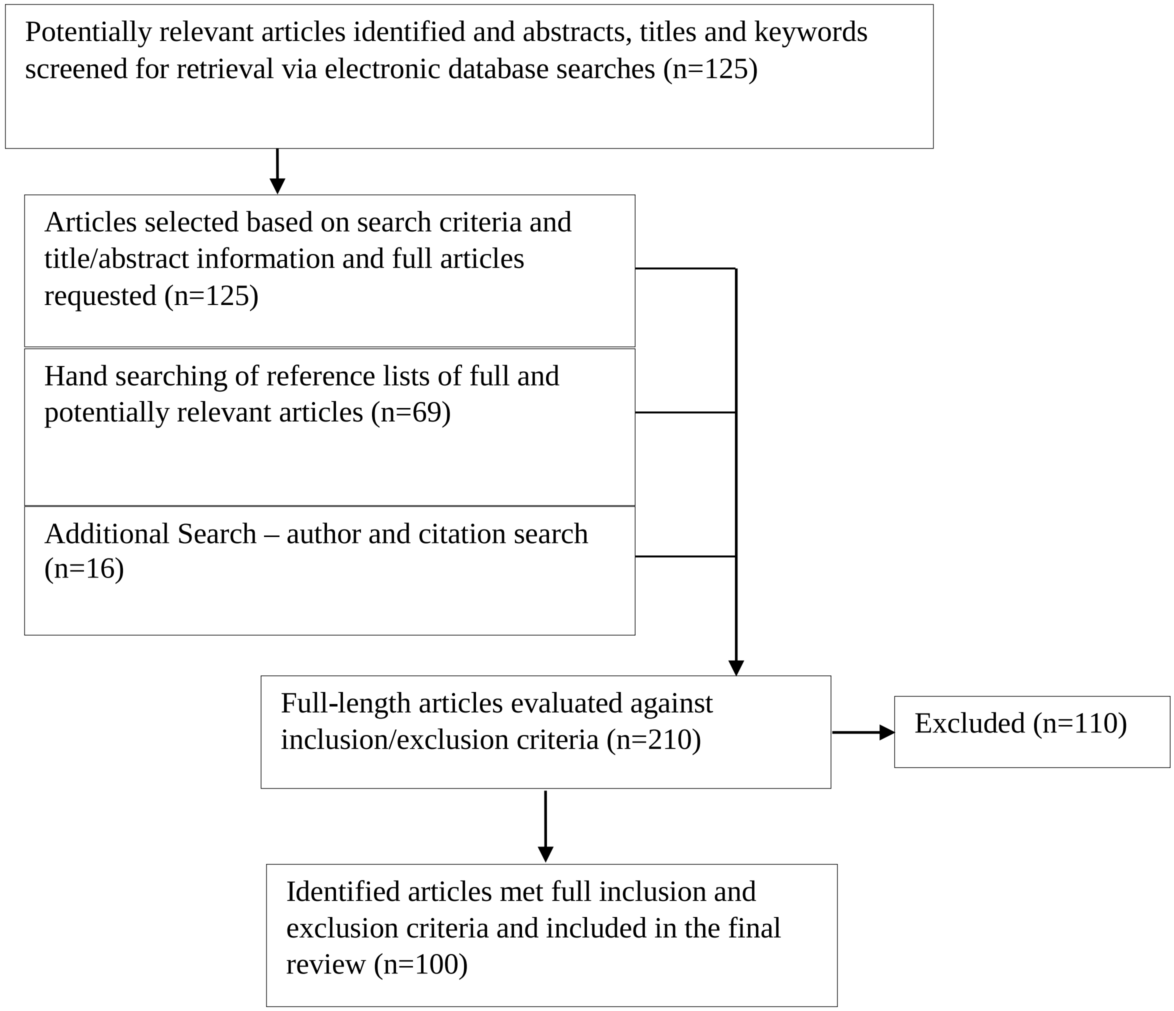

Figure 2.1. Summary of the systematic literature search strategy and the numbers of studies selected or excluded at each stage.

To be retained for final review, an article had to focus on a sport injury prevention measure and mention some aspect of safety behaviours (e.g. mouthguard use) as well as some behavioural determinant/s in relation to the measure (e.g. attitudes). Specific inclusion and exclusion criteria were developed and agreed to by the authors. Full text articles were obtained and their content assessed to determine whether they met the stated inclusion/exclusion criteria (as listed in Table 2.1).

Table 2.1

Inclusion and exclusion criteria for selecting papers to be included in the systematic review

Inclusion criteria	**Exclusion criteria**
Full-text (complete) peer-reviewed, English language, earliest records to July 2009	Studies relating to chronic, recurrent or illness-related conditions
Original research studies	Studies not published in the peer-review literature, reports, reviews, theses and conference proceedings: not reported as full peer-reviewed paper
Studies relating to all ages and both sexes	Intervention/prevention measure studies not considering prevalence of use and determinants of safety behaviour
Sports activities (team/individual) in formal, competitive and social/recreational settings	Bicycle-related studies, including bicycle helmet use studies[a]
Related to the prevention of acute or traumatic injuries	Reviews or commentaries on injury prevention interventions, even if peer reviewed
Unintentional injuries	Studies relating to violence-related behaviours or intentional injuries
Target populations – e.g. sports participants (athletes, players), coaches, officials, parents (or significant others)	
Studies specifically related to specified safety behaviours or behavioural interventions to prevent acute sport injury e.g. protective equipment, warm-up	
Mention of behavioural and social sciences themes, aspects or approach	

[a] Bicycle-related studies were excluded from this review because it is not clear to what extent the bicycling activity described would be related to sport and active recreation, rather than to transportation. Even though this means that many studies of bicycle helmets have been excluded from this review, it is appropriate because most of those helmet-wearing interventions were implemented and assessed in the context of road safety initiatives rather than sports safety.

2.2.2 Classification and review of selected studies

The lead author (AMcG) summarised the key characteristics of the selected studies and classified the use of BSSTM in the studies where applicable. For studies reporting use of BSSTM, details were recorded for the particular BSSTM reported and how they were used.

In the first stage, the use of BSSTM in the selected studies was categorised as belonging to only one of the following categories:

(a) Explicit. Whereby, BSSTM were a clearly stated key aspect in the design or conduct of the study. Studies assigned to this category were required to state that BSSTM were used and to specifically mention the name of the theories or models.

(b) Atheoretical. Where there was no clear evidence for the use of BSSTM in the design or conduct of the study (including unrelated to, lacking a theoretical basis or somewhat implied though not plainly expressed). For example, a number of studies only implied or presented information potentially relating to one or more BSSTM constructs such as risk perceptions, safety attitudes, self-efficacy or perceived behavioural control, with no direct relevance to BSSTM. In these studies, it was not evident whether the particular ‘construct’ used by the authors had been chosen by chance or because of its theoretical basis.

Based on the information provided in the papers, each author independently classified all studies according to the BSSTM use. Any discrepancies in the classifications were resolved through consensus discussion.

In the second stage, studies classified as having explicit BSSTM use were summarised and assessed against the Trifiletti et al. [122] categorization of BSSTM use. This categorization allowed studies to be classified in more than one category. Application of the Trifiletti et al. [122] categorisation required use of BSSTM in these studies to be rated as follows:

(a) Theory was used to guide programme design and/or implementation and/or to select programme measures.

(b) Measurement of a theory or construct or model was undertaken (e.g., data was provided that described predisposing or enabling factors of player safety practices).

(c) A theoretical construct or an extension of a theory (i.e., whether changes or variation in outcomes as predicted by models) was tested (e.g., whether the theory of reasoned action was helpful in understanding variations in beliefs, attitudes, subjective norms and safety practices).

(d) Other. The use of BSSTM did not conform to the aforementioned categorisation or when the study authors did not adequately explain the role of theory or models.

The categories a to c represent Trifiletti et al's. [122] increasing levels of theory application, from (a) low to (c) high, whilst the "other" category (d) did not correspond to a 'level' of theory application.

2.3 Results

2.3.1 Prevention measures in sport injury prevention research

Table 2.2 shows the total number of potential studies identified, total exclusions and inclusions, and the number of studies according to prevention measure categories.

Table 2.2

Overall summary of identified sport injury prevention measure studies at different stages in the review process

Prevention measure	No. of potential studies	Total studies excluded	Total studies included	Atheoretical studies	BSSTM explicit studies (%)[a]
Equipment	7	5	2	1	1 (50.0)
Multi-focused	6	0	6	4	2 (33.3)
General IP	5	0	5	4	1 (20.0)
Education	8	2	6	5	1 (16.7)
Protective equipment	109	36	74	68	6 (8.2)
Specialised exercise	74	67	7	7	0 (0.0)
Total	**210**	**110**	**100**	**89**	**11 (11.0)**

a % denotes BSSTM out of total studies included per prevention measure.

BSSTM = behavioural and social science theories and models; IP = injury prevention

2.3.2 Summary characteristics of the reviewed studies

Table 2.3 summarises the characteristics of the 100 studies that met the inclusion criteria. Most studies (n = 74) related to personal protective equipment (PPE) as the major injury prevention measure. The sporting activities varied from team ball sports, to team bat and ball sports, racquet sports, target and precision sports, individual water sports, individual athletic activities, equestrian activities and wheeled non-motorised sports. Most studies focused on the athletes/players themselves (n = 61 studies) but other common groups were coaches (n = 11), officials (n = 4) and dentists (n = 4). Sixteen studies related to multiple types of participants.

Table 2.3 also indicates the categorisation of each study according to its use or non-use of BSSTM. Overall, of the 100 studies that met the inclusion criteria, only eleven (11%) studies mentioned *explicit* use of BSSTM**.**

Table 2.3

Characteristics of the 100 studies included in this review and classification of their use of behavioural and social science theories and models (BSSTM)

Safety behaviour[a]	**Country of study**	**Categorization of BSSTM use for sport and level of play**		**Study focus**	**Reference**
		Atheoretical	Explicit		
PPE, general	Australia	Australian football; adult/community		Players	[152]
PPE, general	USA	Rugby (female); various		Players	[153]
PPE, general	Ireland	Hurling; adults/inter-county		Players	[154]
PPE, general	USA		Various sports (12 sports); junior/high school (athletes)	Players, coaches	[138]
PPE, general	USA		In-line skating; adult/recreational	Participants	[155]
PPE, general	France		In-line skating; adult/non-specific	Participants	[156]
PPE, general	USA	In-line skating, skateboarding and snowboarding; junior/adolescent extreme sports		Participants	[157]
PPE, general	The Netherlands		In-line skating; junior/children recreational to high performance	Participants	[158]
PPE, general	India	Various sports; junior to adult/high school, college and university		Coaches	[159]
PPE, eyewear	Australia	Squash; adult/competitive and social/recreational		Players	[160]
PPE, eyewear	Australia	Squash; adult/competitive and social/recreational to state		Players	[161]
PPE, eyewear	Australia	Squash; adult/competitive and social/recreational		Players	[162]
PPE, eyewear	Australia	Squash; non-specific level		Players	[163]

Safety behaviour[a]	Country of study	Categorization of BSSTM use for sport and level of play	Study focus	Reference
PPE, eyewear	Australia	Squash; adult/competitive and social/recreational	Players	[164]
PPE, eyewear	Australia	Squash; non-specific level	Venue operator	[143]
PPE, eyewear	Australia	Squash; non-specific	Players, venue managers	[165]
PPE, eyewear	Australia	Squash; adult (pennant)	Players	[166]
PPE, facial protection	USA	Ice-hockey (indoor); adult/recreational	Players	[167]
PPE, faceguard	USA	Baseball; junior/youth league	Players, coaches and parents	[168]
PPE, headgear	Australia	Rugby union; junior/interschool	Players	[73]
PPE, headgear	Australia	Australian football; adult/amateur/community	Players	[169]
PPE, headgear	USA	Rugby union; adult/university	Players	[170]
PPE, headgear	Australia	Surfing; non-specific level	Participants	[171]
PPE, headgear	USA	Organized equestrian; non-specific level	Participants	[172]
PPE, headgear	USA	Wrestling; collegiate/division 1	Wrestlers	[173]
PPE, headgear	USA	Skiing and snowboarding; adult/non-specific	Participants	[174]
PPE, headgear	USA	Skiing; adults/non-specific	Ski-shop owners	[175]
PPE, headgear	USA	Skiing and snowboarding; adults/non-specific level	Ski patrollers	[176]
PPE, headgear	Canada	Rugby union; junior to adults/high school to national level	Players, coaches	[177]
PPE, mouthguards	Australia	Rugby; adult/elite international	Players	[178]
PPE, mouthguards	Australia	Rugby; adult/elite international	Players	[179]
PPE, mouthguards	Australia	Rugby; adolescents/high school (private)	Players	[180]
PPE, mouthguards	Australia, Scotland, Ireland, Wales	Rugby; adult/elite international	Players	[181]
PPE, mouthguards	UK	Rugby; adult/elite international	Players	[182]
PPE, mouthguards	UK	Rugby; non-specific level	Players	[183]
PPE, mouthguards	UK	Rugby league; adult/elite super league	Players	[184]

Safety behaviour[a]	Country of study	Categorization of BSSTM use for sport and level of play	Study focus	Reference
PPE, mouthguards	UK	Rugby; adult/various levels	Players	[185]
PPE, mouthguards	USA	Rugby; adult/elite international	Players	[186]
PPE, mouthguards	USA	American football; adult/university (freshman)	Players	[187]
PPE, mouthguards	USA	Football; junior/high school varsity	Players	[186]
PPE, mouthguards	USA	Football; junior/high school varsity	Players	[187]
PPE, mouthguards	USA	Basketball; junior/high school varsity	Players	[188]
PPE, mouthguards	Australia	Basketball; junior to adult/social to elite	Players	[189]
PPE, mouthguards	China	Basketball; adult/professional and semi-professional	Players	[190]
PPE, mouthguards	USA	Ice hockey; adult/university NCAA men's division 1	Players	[191]
PPE, mouthguards	USA	Ice hockey; junior/high school	Players	[192]
PPE, mouthguards	UK	Field hockey; adult/elite premium division	Players	[193]
PPE, mouthguards	Turkey	Tae Kwon Do; junior/elite	Players	[194]
PPE, mouthguards	Japan	Various sports (4 sports); adolescents/high School	Players	[195]
PPE, mouthguards	Singapore	Various sports; junior/high school	Players	[196]
PPE, mouthguards	Nigeria	Various sports; junior to adult	Players	[197]
PPE, mouthguards	USA	Various sports; junior/high school	Coaches	[198]
PPE, mouthguards	Nigeria	Various sports; junior/high school	Coaches	[199]
PPE, mouthguards	Switzerland	Various sports; adult/national level	Players, officials	[200]
PPE, mouthguards	Brazil	Various sports; adult/semi-professional to professional	Players	[201]
PPE, mouthguards	USA	American football; adult/university NCAA division I-A	Coaches	[202]
PPE, mouthguards	USA	Ice hockey; adult/university NCAA division I, II, and III, and independent varsity ice hockey programme	Athletic trainers	[203]
PPE, mouthguards	USA	Football; adult/university NCAA division I-A	Officials	[202]

Safety behaviour[a]	Country of study	Categorization of BSSTM use for sport and level of play	Study focus	Reference
PPE, mouthguards	USA	Football; adult/university NCAA division I-A	Officials	[204]
PPE, mouthguards	USA	Soccer; junior/competitive	Parents	[205]
PPE, mouthguards	USA	Various sports; junior/public school	Parents	[206]
PPE, mouthguards	USA	Soccer; junior/non-specific	Parents	[207]
PPE, mouthguards	USA	Various sports; non-specific	Dentists	[208]
PPE, mouthguards	USA	Various sports; non-specific level	Dentists	[209]
PPE, mouthguards	Singapore	Various sports; non-specific level	Dentists	[210]
PPE, mouthguards	Nigeria	Various contact sports; non-specific level	Dentists	[211]
PPE, mouthguards	Turkey	Various sports; junior/high school coaches and university athletes	Coaches, players	[212]
PPE, mouthguards	Turkey	Various sports; adult/university coaches and players	Coaches, players	[213]
PPE, mouthguards	Switzerland and Germany	Handball; adult/amateur, semi-professional	Coaches, players	[214]
PPE, mouthguards	Switzerland, Germany and France	Squash; junior, adult/juniors, amateur, semi-professional and professional	Coaches, players	[215]
PPE, mouthguards	USA	Football; junior/high school varsity	Coaches, trainers	[216]
PPE, mouthguards	UK	Rugby union; adult/elite players and community level parents of junior players	Players, parents	[217]
PPE, mouthguards	Australia	Australian football; junior to adult/amateur	Players, spectators (family and friends)	[218]
PPE, mouthguards	USA and Canada	Ice hockey; junior to senior/all levels	Players, trainers, dentists	[219]
Equipment, safety baseballs	USA	Baseball; junior/little league	President	[220]
Equipment-ski bindings	USA	Skiing; adult/non-specific	Skiers	[221]
General injury prevention	UK	English football (soccer); adults/professional non-specific level	Players	[222]
General injury prevention	Australia	Australian football; junior/elite	Players	[123]

Safety behaviour[a]	Country of study	Categorization of BSSTM use for sport and level of play		Study focus	Reference
General injury prevention	USA	Ice Hockey; junior/non-specific level		Players	[223]
General injury prevention	Australia	Little athletics; junior/non-specific level		Participants	[224]
General injury prevention	Australia	Rugby union; junior/community		Coaches	[225]
Specialised exercise, tackling 'spearing' and rule enforcement	USA	American football; junior/high school		Officials	[226]
Specialized exercise, tackling 'spearing'	USA	Football; junior/high school level		Players, coaches	[227]
Specialized exercise, warm-up	Australia	Golf; adult/non-specific level		Players	[228]
Specialized exercise, pre-exercise stretching	USA	Various sports; junior/high school level		Coaches	[229]
Specialized exercise, intervention	USA	Soccer; NCAA division 1 (female)		Coaches	[114]
Specialized exercise, non-intervention	Australia	Australian football; adult/elite		Coaches	[124]
Specialized exercise, non-intervention	UK	Cricket; adult/first-class county		Coaches	[230]
Multi, non-intervention (SEE)	Australia	Skiing/snowboarding; adults/various levels (beginners/intermediate/advanced)		Skiers	[231]
Multi, intervention	New Zealand		Rugby union; population wide	Multi-focused	[145]
Multi, intervention	USA	Skiing/snowboarding; junior, adult/non-specific level		Multi-focused	[232]
Multi, non-intervention (SEE)	USA		Basketball; high school varsity, junior varsity, division III Massachusetts South Coast conference coaches	Players, coaches	[111]
Multi, non-intervention (SEE)	New Zealand	Soccer; junior		Players	[233]

Safety behaviour[a]	Country of study	Categorization of BSSTM use for sport and level of play		Study focus	Reference
Multi, non-intervention (SEE)	Australia	Skiing/snowboarding; adults/various levels (beginners/intermediate/advanced)		Skiers	[234]
Education intervention	The Netherlands	Running; adults/non-specific		Runners	[235]
Education intervention	The Netherlands	Skiing; various participants/levels (beginners to advanced)		Skiers	[236]
Education intervention	Australia	Soccer; adults/various club officials		Officials	[237]
Education intervention	New Zealand	Netball and soccer; various levels/non-specific level		Coaches	[238]
Education intervention	USA		Various sports; adolescent/high school athletic coaches	Coaches	[239]
Education intervention	Australia	Basketball and rugby; junior/non-specific		Players, coaches parents	[240]

a General PPE refers to multiple types of PPE considered in the one study, e.g. helmets, wrist guards, knee and elbow pads.

NCAA = National Collegiate Athletic Association; PPE = personal protective equipment; SEE = specialized exercise and education.

Non-specific- denotes authors did not specify level of sport

2.3.3 Theories and models used in sport injury prevention research

Table 2.4 summarises the specific BSSTM used in the eleven studies stating explicit use. Of the studies that explicitly mentioned BSSTM, seven were related to the use of PPE [138,143,155,157,173,221,241]. Only the Theory of Reasoned Action/Theory of Planned Behaviour [111,123,221,241] and Diffusion of Innovation [173,239] were used in more than one study. When explicit studies were rated according to the Trifiletti et al. [122] categorisation of BSSTM use, it was apparent that the majority (n = 8) had used BSSTM to guide programme design and/or implementation, or to measure a specific theory or a theoretical construct (n = 7); only four studies formally tested a theory and three studies did not meet any of the aforementioned criteria and was specified as ‘other’.

Table 2.4

Summary of behavioural and social science theory and models (BSSTM) explicitly stated as being used in sports injury research studies

BSSTM	**Safety behaviour under investigation**	**Trifiletti et al. categorisation [122] of BSSTM use**	**Reference**
Health Belief model	Protective equipment	Tested theory	[155]
Theory of Reasoned Action/Theory of Planned Behaviour	General injury Prevention	Guided programme design and/or implementation Measured theory or construct	[123]
Theory of Reasoned Action/Theory of Planned Behaviour	Multi-intervention (SSE)	Measured theory or construct	[111]
Behavioural Intention model (otherwise known as Theory of Reasoned Action)	Equipment, ski bindings	Guided programme design and/or implementation Measured theory or construct Tested theory	[221]
Theory of Reasoned Action/Theory of Planned Behaviour (including threat perceptions)	Protective equipment	Guided programme design and/or implementation Measured theory or construct Tested theory	[241]
Social Cognitive Theory	Protective equipment	Guided programme design and/or implementation Measured theory or construct	[138]
Attitude-Social Influence Self-Efficacy model	Protective equipment	Guided programme design and/or implementation Tested theory	[157]
Refined Ecological model	Protective eyewear	Guided programme design and/or implementation Other	[143]
Diffusion of Innovation Theory	Protective headgear	Other	[173]
Diffusion of Innovation Theory	Coach education, general injury prevention	Guided programme design and/or implementation Measured theory or construct	[239]
PRECEDE-PROCEED model[a]	Multi-intervention	Guided programme design and/or implementation Measured theory or construct	[145]
Ottawa Charter[a]	Multi-intervention	Other	[145]

a PRECEDE-PROCEED model and Ottawa Charter applied in the same study; [145] (identified 12 BSSTM; n = 11 studies).

2.4 Discussion

It is critical that sports safety interventions have a strong evidence-base for their efficacy and effectiveness before they are delivered to players, coaches and sporting bodies. It is equally important that they are both effective from a public health perspective and can be readily adopted and maintained in the 'real world' Although it is now accepted that behavioural approaches are useful for understanding, explaining and changing behaviour related to injury problems [121,141] and are an important consideration in intervention effectiveness, [116] this review highlights the lack of BSSTM applications to published sport injury prevention research. This is a concern because most solutions to preventing the sport injury problem rely on some form of behaviour change or modification on the part of players, athletes, coaches, officials, administrators or peak sports bodies [31,138,139,143]. Whilst this review found quite a large number of studies relating to sport injury prevention measures with some behavioural basis, only 11% applied any formal theoretical considerations to their study, suggesting that most authors in this area are either not aware of the importance of BSSTM, or do not appreciate the value of theoretical underpinnings and their application to practice, or may simply lack the knowledge, expertise or requisite skills/training to utilise them.

When BSSTM were used in the published sports injury studies, this tended to be in relation to individual-level (intrapersonal/interpersonal) theories. These included the health belief model [155,242], theory of reasoned action/theory of planned behaviour [111,123,221,241], attitude-social influence-self efficacy (ASE) model (an elaboration of the theory of planned behaviour) [157,243], and social cognitive theory [138,244]. This is quite appropriate and not surprising given the focus on ensuring the safety of individuals involved either in team sports or as individual participants of activities such as skating. However, recent commentary has stressed that it is more than just individual (i.e., player) factors that affect uptake and adoption of safety measures, and hence sustained behaviour change [116]. Such factors relate to the capacity of the full sports delivery system to deliver and implement preventive measures for the benefits of sports participants [116].

Despite the increasing availability of evidence-based sports injury prevention measures, sports safety efforts to date have been hampered because limited research attention has focused on understanding the intervention implementation context and processes, including barriers and facilitators to sustainable programmes [31,116,139]. This knowledge gap requires not only the use of individual-level theories but also the application of organisation- and community-level theories. This review has confirmed that organisational- and community-level theories have rarely been used, with the exception of a refined ecological model [143], the diffusion of innovation theory [173,239], the PRECEDE-PROCEED planning model [145] and the Ottawa charter [145]. Further application of BSSTM at multiple-levels of behavioural influence (i.e., aligning individual, organizational and community) in this area of research should strengthen the design of intervention strategies and ensure sustainability of implemented programmes. Their direct application could be used to develop different intervention strategies and methods when working with either individuals or communities [119,121] in different sports settings. For example, at the individual level, intervention strategies could include a variety of behavioural, educational, counselling, skills development and training methods [119,120]. At the organisational and community level, the use of social marketing, mass media and media advocacy are important, as well as coalition building, social planning and community development [119,120].

Another significant gap highlighted by this review is that many of the common theories from the behavioural literature were not identified in the reviewed sports injury studies; these include the protection-motivation theory [245], stages of change/transtheoretical model [120,246], precaution adoption process model [247], applied behavioural analysis [121], social networks and social support [248], self-efficacy [249], community organisation and mobilisation theories (including empowerment, capacity, participation and relevance) [250], communication theories [251], organisational development theory (including organisational culture, climate and capacity) [252], the RE-AIM (reach, effectiveness-adoption, implementation and maintenance) model [253] and social marketing [254]. Given the success of application of these BSSTM to other safety behaviours and health issues [255,256], there could be considerable merit in also applying them to the sports injury context [116]. For instance, applied behavioural analysis [119,121] theory has been used in many injury settings (e.g., road safety [257,258], child safety [259], and occupational settings [260]) to change behaviour, but has yet to be applied to sports injury. Unlike the review conducted by Trifiletti et al., [122] which found the PRECEDE-PROCEED planning model was most commonly used in unintentional injury prevention, our study has highlighted that this model has only been used in one sports injury prevention study to date [145]. The reasons for this are unclear, but could reflect the relative infancy of the application of BSSTM underpinnings to sports injury prevention.

All BSSTM can be applied at various stages of the research process. We applied the Trifiletti et al. [122] categorisation to ascertain how theory had been used in the sports injury studies that adopted it. The most common application was used to guide programme design and/or implementation, and/or select programme measures of a study. This implies a low level of theory application according to Trifiletti et al., [122] and demonstrates a significant absence of the systematic application of BSSTM to sports injury research. Most studies that did apply theory to programme design were also categorised as measuring a theory, construct or model, thereby strengthening their theory application moderately. There was little evidence of testing theories, to determine what might be most applicable to the sports injury context. Without this information, researchers who want to apply BSSTM appear to just select random constructs that they think may be relevant, without formal justification or rationale for their choice.

Often it seems that sport injury studies address constructs relevant to behaviour change in general, but there is little evidence of studies actually committing to the application of specific theory and systematically designing methods, such as questionnaires, accordingly. This is reflected in the large number of atheoretical studies. This could indeed lead to results that are neither replicable nor generalisable to other player groups or different interventions. Moreover, atheoretical studies are unlikely to build on existing behavioural knowledge and run the risk of omitting important psychosocial determinants and processes central to behaviour change. Although theory-based studies are more likely to provide a strong empirical foundation for evidence-based prevention approaches, this does not mean that nothing can be learnt from *atheoretical* approaches. There is still a role for them in informing future theoretical studies, guiding implementation efforts and highlighting future research questions.

2.4.1 Limitations

Although an extensive search strategy was adopted, it is possible that the ability to locate relevant papers for the review was limited by the use of specific keywords or series of keywords. Using search terms relating to common theories only resulted in two studies being found; these two studies were also identified using alternative search terms. This restriction to only common theories may have limited identification of other useful or newly emerging theories. However, we do not expect this to be a major omission because our search strategy did identify one study that used the ASE model [157] and another that applied a refined ecological model [143], which are uncommon in the general literature. It is acknowledged that a recent review of behavioural research in the broader injury prevention context [122] identified a larger range of theory applications (e.g., health belief model, theory of reasoned action/theory of planned behaviour, social cognitive theory, diffusion of innovations, PRECEDE-PROCEED and social marketing theory) than we were able to find in the sports injury prevention literature. Moreover, although excluded from this review, there is recognized use of BSSTM in studies of bicycle helmets and bicycle safety (see references [261-263] for examples).

Our process of searching, which included hand searching reference lists and additional author searches, did identify further studies and highlight the problem of how articles are indexed in databases. We excluded non-peer-reviewed (grey) literature, such as conference proceedings and dissertations, and this may have limited the identification of theory applications in sport injury prevention contexts, though we consider this unlikely. It is possible that some authors of peer-reviewed studies are not reporting full details of their use of BSSTM due to factors such as length restrictions applied by journals. If this were the case, then the number (and proportion) of papers we assigned to the atheoretical categories of BSSTM use may be overestimated. If the field is to progress and researchers are to benefit from the accumulated wisdom of others, it would be pertinent for authors to include these details in their papers and for journal editors to require it formally. Without this, it is likely that researchers will continue to make the same 'mistakes' resulting in critical components of interventions, their target behavioural variables and maximal implementation strategies not being identified.

The initial search for articles relied on abstract content only; it was, however, apparent that some studies seemed to have a behavioural approach (i.e., implementing an exercise programme) and did not clearly link to the stated exclusion criteria in the first instance. A full-text review of these 'unclear exclusion' studies was undertaken. None of the unclear exclusion studies mentioned theory applications; however, some did mention outcome measures (e.g. attitude, knowledge and behaviour) in the method/discussion section and, subsequently, were included in the review (see Braham et al. [152] for example).

2.4.2 Implications for future research

The lack of evidence supporting the widespread use of BSSTM in the design, implementation and evaluation of sports injury interventions results in difficulty providing clear direction or strategies to enhance uptake of sport injury prevention interventions. Unfortunately, the current status of the field also does not appear to assist in enhancing theory development in sport injury prevention research. Previous reviews of sports injury studies have also noted many problems with the quality of their research designs [137] and until these are addressed uniformly, this may have implications for sports injury prevention. Having said this, whether the application of BSSTM to sport injury prevention contexts will improve the uptake of sport injury interventions is largely unanswered, but the evidence from other areas of public health priority suggests it should play a key role. To date, very few studies have used BSSTM; when applied, their use has been varied, with no studies being undertaken in the same sporting setting to enable comparisons of theories or consistency of findings to be established.

Extending current work to the evaluation of the robustness of behavioural findings when theory is applied to particular sport injury prevention issues, and determination of what theories and models work best for specific sport injury prevention topics is needed. It is recommended that further research be conducted to compare or even integrate theories, so that the safety recommendations arising from future research studies take into account the complexity of sports behaviours and settings and the multitude of factors contributing to injury risk. It is unlikely that a single theory will be shown to explain the dynamics of safety behaviours in sporting contexts fully. Rather, it is likely that existing theories will need to be extended or refined to incorporate multi-level approaches. The extended ecological model of Eime et al., [164] is one step in this direction.

Finally, given the widespread use of BSSTM in other application areas (such as exercise promotion, occupational safety and road safety) valuable lessons could be synthesised and translated to the sport injury prevention area to reduce investment in unnecessary and costly duplication of efforts. Importantly, the sports injury prevention research field needs to embrace interdisciplinary collaborations and partnerships. This will enhance the applicability and relevance of research programmes to real-world safety applications and contexts (and vice versa). Significant injury reductions will only be achieved at a population level if research efforts contribute to collectively changing individual behaviours, environmental conditions and social structures to develop supportive safe sports contexts [31,116].

2.5 Conclusion

This review has highlighted the general lack of use of BSSTM in studies relating to unintentional sport injury prevention research. Future research in this area, incorporating such approaches is needed in studies that are rigorously designed and analysed. It will also be important to interweave BSSTM approaches into the mainstream of sport injury prevention research, through increasing multidisciplinary/interdisciplinary research teams. There already exist a number of BSSTM applications that researchers could use in enhancing the uptake of sport injury prevention measures, and new behaviour change theories and models are constantly emerging [120]. The field needs researchers who are willing to put these theories to the test. Advances in BSSTM development, as well as increased attention to behaviour change research, will provide new opportunities for reducing injuries and enhancing the uptake of preventive measures. By combining the usual sports injury prevention methods with BSSTM, the field will obtain a better understanding of how and why sports participants (and the settings they play in) make safety-related decisions and what enhancements can be made to injury prevention strategies to ensure their sustained uptake. As Trifiletti et al. [122] posits "It will take creative researchers to find the nexus" (page 305).

Chapter 3: Application of BSSTM in Sport Injury Prevention Research

3.1 Introduction

Historically, sport injury prevention research has focused on sports medicine, epidemiology, and biomechanical approaches. Although there have been important developments in using these approaches, there seems to be a disparity in integrating the use of behavioural science to advance injury prevention [31,127,264-266]. Unfortunately, it is often assumed that research that has been shown to prevent injury in experimental contexts will be automatically transferred into real-world sporting contexts [31]. There is no or little consideration for whether research will be effectively used, or even maintained in practice, by sporting participants. The assumption is often made that after an innovation is developed, and its efficacy and effectiveness demonstrated related to direct injury outcomes, widespread adoption and uptake will occur automatically [264]. However, there is evidence that researchers' (e.g. sport biomechanics specialists) initial attempts at implementation do not typically lead to sustained use of effective sport injury prevention programs (or measures), and that uptake by the intended "end users" (e.g., coaches, players) beyond this is typically even poorer [127].

Implementation and evaluation research is only beginning to emerge in the sport injury arena and demonstrates the clear need to use more "active approaches"—the use of behavioural and social sciences theories and models (BSSTMs) [31,127,264-266]. A major challenge for sport injury-related practitioners and researchers is to identify ways to activate the change process at a personal, organisational, or community-wide level, rather than relying solely on passive diffusion [121,141,267-269]. Ensuring a more "active" approach, through tailored and evaluated behaviour change strategies can maximise the exposure and reach of successful interventions, thus increasing their impact on public health [121,141,267-273].

This chapter aims to expand upon the systematic review in Chapter 2 and describe the common theoretical models and studies addressing BSSTM in further detail. The only studies reviewed in detail in this chapter are those that were included in Chapter 2. More recent studies using BSSTM are acknowledged in a summary table in Appendix E.

3.2 Individual-Level Theories

3.2.1 Health belief model

The health belief model (HBM) is one of the most enduring theoretical models associated with preventive and other health-related behaviours [242,274-276]. It was initially conceived in the 1950's by a group of social psychologists (Hochbaum, Rosenstock, and Kegels) in the United States Public Health Service in an effort to explain the widespread failure of people to participate in programs to prevent or to detect disease [277]. The model was specifically developed in response to the failure of a free tuberculosis (TB) health screening program [274]. The HBM has since had its applicability extended to both explaining change and maintenance of preventive, and health behaviour and to provide a guiding framework for behaviour interventions [155,278-284].

At its core, the HBM suggests that the likelihood of an individual taking action related to a given health problem is based on the interaction between four different types of beliefs [285]. The model predicts that individuals will take action to protect or promote health if: (1) they perceive themselves to be susceptible to a condition or problem (e.g., likelihood of sustaining a hamstring injury); (2) they believe an illness or injury condition will have potentially serious consequences (e.g., having a bicycle accident could have a negative impact on their life); (3) they believe a course of action is available that will reduce their susceptibility to illness or injury condition (e.g., use of headgear will reduce the chance of a head injury), or minimise the consequences of an illness or injury condition;

and (4) they believe that the benefits of taking action will outweigh the costs or barriers (e.g., benefits of helmet wearing versus discomfort, perceived foolish appearance) [119,151,242,285].

Refinements of the original model acknowledged important modifying factors that can influence beliefs or behaviour, particularly those associated with personal characteristics (e.g., knowledge and socio-demographic factors) as well as the impact of more immediate cues for action, such as publicity (e.g., media campaigns) or personal experience (e.g., a personal injury in the past or witnessing of a friend/family member getting injured) [242]. Cues to action, however, have not been extensively explored or understood in the general, nor the sport injury prevention literature [280]. As a further factor influencing the strength of the model in predicting behaviour change, the concept of self-efficacy was included in the 1990's to address the challenges of habitual behaviours such as smoking and overeating [286]. Self-efficacy refers to the belief in ones' competence to take appropriate action [285]. For example, if a coach feels confident that they can deliver specific exercises to his or her players, they may be likely to adopt and maintain specific exercises in their training practices (preventive behaviour). Figure 3.1 summarises the different elements and linkages of the model.

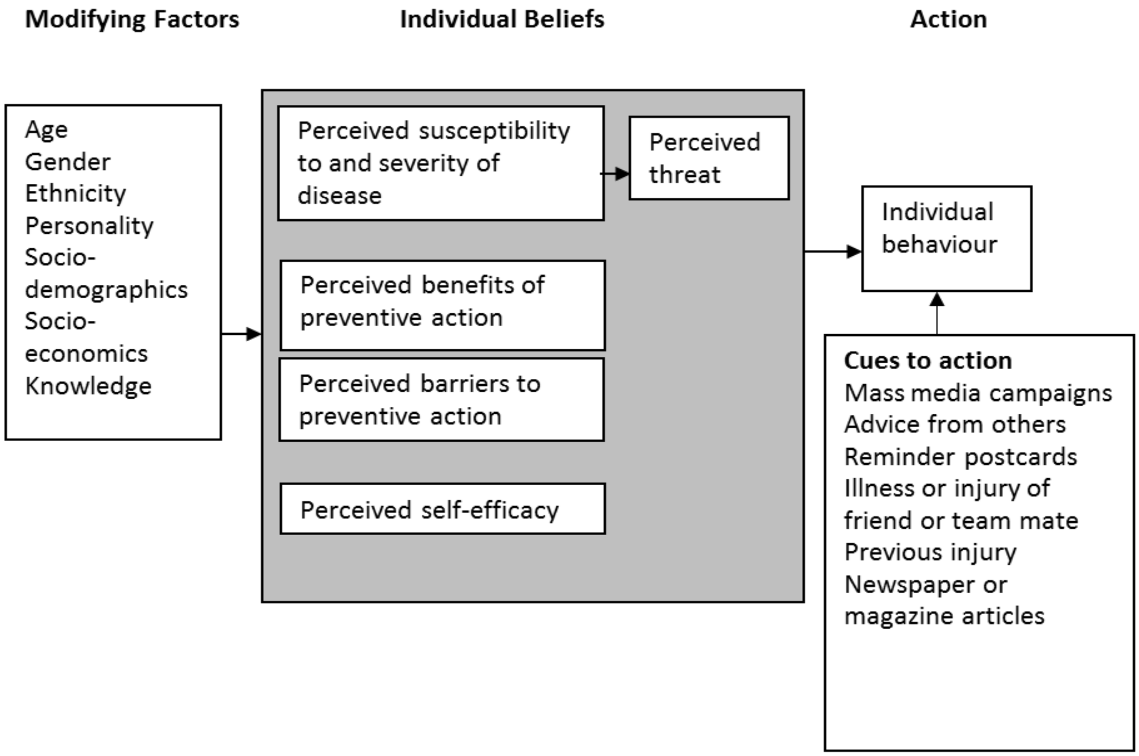

Figure 3.1. Health belief model components and linkages. Adapted from [242,285]

As an illustration of the HBM, Williams-Avery and McKinnon [155] conducted a study to explore in-line skating injuries and personal protective equipment (PPE) use in a sample of college students at Arizona State University. They also identified important predictors of PPE using HBM constructs, including injury history and safety norms. Students (*n = 411*) were randomly sampled from an introductory psychology subject in 1993 to complete an in-line skating questionnaire, during a scheduled class period. The questionnaire consisted of 25 items to test the applicability of the HBM and 25 questions about PPE use, injury history and safety norms. Completed questionnaires from 217 students who indicated they previously in-line skated on the questionnaire were included in this study.

Of the students sampled, the greatest proportion (49.3%) indicated they used their in-line skates for recreation or fitness, with 70 (33%) in-line skaters reporting that they generally wore no PPE at all when in-line skating, and only 3 (1.4%) ever wore full PPE (i.e., helmet, wrist guards, and knee and elbow pads). Only 14 skaters (6.5%) reported that they consistently wore their PPE and more women than men reported consistent use of PPE. The majority of the sample did not own any protective equipment (57.5%) and only 8.8% wanted to own all protective equipment items. Elbow and knee pads, which protect against minor injuries, were the most common pieces of equipment worn.

Some possible modifying factors influencing PPE use were identified in this study, including in-line skating experience, past injury, and socio-cultural factors [155]. The more experienced the in-line skaters, the less likely they were to wear PPE. Most in-line skaters in this sample had never been injured (64.4%), approximately one third of them had experienced an injury such as an abrasion, and only 2% had sustained more serious injuries. The more experienced skaters accounted for 80% of all serious injuries. It is, however, not clear from the data provided in this study whether more experienced in-line skaters accounted for more injuries because of greater exposure or because they were less likely to wear PPE. It was found that the incidence of minor injuries decreased as the frequency of PPE use increased. The frequency of more severe injuries (fractures and head injuries) was highest among those in-line skaters who wore PPE approximately half of the time. The causal direction of this relationship was, however, difficult to establish, with the authors [155] suggesting that one explanation is that individuals who were injured then decided to wear PPE. The researchers [155] further suggested that this finding may be explained by the association between injuries and susceptibility and that over 85% of in-line skaters believed that if they had a serious in-line skating accident they would want to wear PPE more regularly. In addition, other factors such as "general clumsiness or lack of confidence; and the possibility that when PPE is worn, skaters are more cautious and therefore less likely to be injured", were suggested. Although not mentioned, the use of PPE could also be dependent on the severity of the injury; and whether it was a major versus minor injury. In addition, past injury ("an event or a stimuli") could also be captured as a cue to trigger the decision-making process and motivate an individual to take action such as wearing PPE. Although 74% of in-line skaters reported that they had viewed promotions to encourage the use of PPE (cues to action), a popular perception among skaters in this sample was that “less than 10% of all skaters wear all PPE”.

Based on previous study findings in preventing bicycle-related head trauma [287], exploring the construct of self-efficacy and injury may have added further light on wearing PPE. The authors pointed to the implications of the findings and highlighting the need to understand the psychological change process as skaters become more experienced in their skating abilities and the impact of injury on the learning process and subsequent PPE use being incorporated into preventive strategies.

In this study [155], four of the major HBM constructs (1) “perceived barriers” to wearing gear, (2) “perceived susceptibility” to injury, (3) “perceived severity” of injury, and (4) “perceived benefits” of wearing gear, were shown to be significant predictors of PPE use. Perceived barriers, perceived susceptibility, and perceived benefits were strongly associated with PPE items typically worn and with the frequency of PPE use. Overall, perceived barriers were the most important predictor of PPE use, followed by perceived susceptibility. Indeed, the perceived barriers construct has reliably yielded the highest significant ratios among differing types of behaviours in the empirical literature (i.e., individual decisions/actions to adopt a preventive or health behaviour is mostly influenced by their perceived barriers towards the target behaviour) [242,263,279,288-290].

The most common reason given for not wearing PPE in this study was that it was perceived as unnecessary; other reasons included it was uncomfortable, foolish looking, inconvenient, or peers did not approve. The authors [155] suggested that the barriers, susceptibility and benefits constructs may be important targets for injury prevention strategies. Specifically, they recommended methods to reduce barriers and increase perceived susceptibility to injury are needed, in addition, to making the social normative climate more conducive to wearing PPE (which may impact both the barriers and susceptibility constructs). Nonetheless, they did not elaborate on what specific methods (or strategies) could be utilised, thus making it difficult for researchers or community practitioners to utilise such data in further research or practice settings. Furthermore, for the purposes of developing an educational program, as an example, it would have been useful to have data on in-line skaters' perceptions on various aspects of the major dimensions of the HBM, however upon review of measures of each dimension these appear limited or are not adequately described.

Consistent with previous HBM research [242], perceived severity was the construct least associated with preventive behaviours (PPE worn and the frequency of PPE use), suggesting that individuals in this sample may not hold strong beliefs about the seriousness of sustaining an injury and/or consequences of injury [155].

Moreover, perceived severity is generally the least powerful in relation to preventive behaviours, but has been strongly related to sick-role behaviours (actions taken after a diagnosis of a medical problem in order to restore good health or to prevent further disease progress) [242]. It could be speculated that the findings for "perceived severity" among in-line skaters may be due in part to difficulties that study respondents have in conceptualising this dimension: (1) when they are asymptomatic; (2) for health threats that are usually thought to be long term; (3) concerning medical conditions or injury with which they have little or no experience; or (4) if they have the ability to control the situation or not. The investigators [155] made no conclusions regarding the association between perceived severity and PPE use and what implications this has, if any, in this context. It may be that in sporting settings or situations individuals have an unrealistic optimism that "it won't happen to me". Increasing the strength of perceived severity beliefs in intervention efforts may be required to carry more weight as a determinant of PPE use.

A number of other design features of this study [155] also render interpretation of these findings problematic, including: (1) use of a cross sectional design precluding causal conclusions; (2) sample size; (3) the unique socio-demographic or use of a rather circumscribed population of college students at risk (thus limiting generalisation of findings); and (4) the roles of cues to action and self-efficacy construct's needing to be explored further [263] as little is known about these construct, particularly cues to action [263,280] or their relative impact; and, (5) the manner in which the belief dimensions were operationalised raising questions about in-line skater's interpretations of health belief items. For example, although perceived severity was measured as "an in-line skating accident may result in broken bones, head injuries and lifelong damage", this statement could be interpreted as somewhat arbitrary or "double-edged" in that in-line skaters may think they will get broken bones but not perceive head injuries or lifelong damage as a result of an in-line skating accident. This has implications for how they answer questions, and subsequently the interpretation of the results.

Additionally, it may have been valuable for the authors to use an anchor scale to measure this construct such as "not at all severe - very severe". Also the study's operationalisation of a perceived susceptibility item (e.g.," if I in-line skated on roads or sidewalks I would be afraid of being hit by a car or failing on pavement at high speed") and perceived barriers (e.g., "people who wear protective gear when biking or in-line skating look ridiculous; I would be embarrassed to wear a helmet and wrist guards or pads around campus") render the same problem as the latter, in that – the wording of belief questions is "double-edged".

In their conclusions, the authors pointed to the need for more detailed questions, but it could be equally argued that the questions they used need to be further simplified and more specific to capture the HBM variables associated with PPE use in in-line skating. Although the investigators mentioned obtaining adequate internal consistency amongst construct measures, the reliability of grouping questions in the questionnaire that measured the same construct could be limited for the reasons stated above, as items may be inappropriate or inadequate indicators of a particular concept. The absence of reliable and valid measures not only limits the practical utility of the theoretical formulation, but also reduces the potential for developing a reliable body of knowledge on which to design intervention strategies to change health or preventive behaviour [291-294].

Despite the limitations of the use of the HBM in this study, it provides a unique insight into PPE preventive behaviours of in-line skaters and could provide a compass to guide research to explain preventive behaviours of other in-line skaters and sporting participants. It may be important to undertake qualitative (elicitation) research in the future to understand the full extent of salient beliefs of in-line skaters, prior to developing future scales of the HBM to administer to in-line skating populations and certainly other sports.

3.2.2 Theory of reasoned action/theory of planned behaviour

The Theory of Reasoned Action (TRA) and Theory of Planned Behaviour (TPB) focus on theoretical constructs concerned with individual motivational factors as determinants of the likelihood of performing a specific behaviour [151,269,295,296]. The TRA (Figure 3.2) assumes the best predictor of behaviour is behavioural intention, which in turn is a product of attitude toward the behaviour (a function of beliefs concerning the perceived consequences of a particular behaviour, and a personal evaluation of these consequences) and subjective norm perceptions (a function of perceived expectation of salient others towards a behaviour, and the motivation to comply with these expectations) [269,296,297]. The TPB (also in, Figure 3.2) is an extension of the TRA with the addition of a single factor, perceived behavioural control (PBC) [297,298]. The factor of PBC was conceptualised and extended the TRA to account for real and perceived limitations to performing a behaviour, thus implying, that intentions cannot be the sole predictors of behaviour as stated in the TRA, especially in situations in which people may lack control over the behaviour (i.e., lack control due to circumstances, the individual's skills or behavioural repertoire) [297]. In addition to the notions of attitudes and subjective norms, the TPB states that PBC relates to the perceived likelihood of encountering factors that will facilitate or inhibit the successful performance of the behaviour (control beliefs), weighted by their "perceived power" or the impact of each control factor to facilitate or inhibit performance [297]. Few studies have operationalised PBC using these underlying measures of control beliefs and perceived power; instead, researchers have mostly used the direct measure of perceived behavioural control [299]. The TPB, in essence, is viewed as a direct predictor of behaviour via intentions and also a direct predictor of behaviour [151].

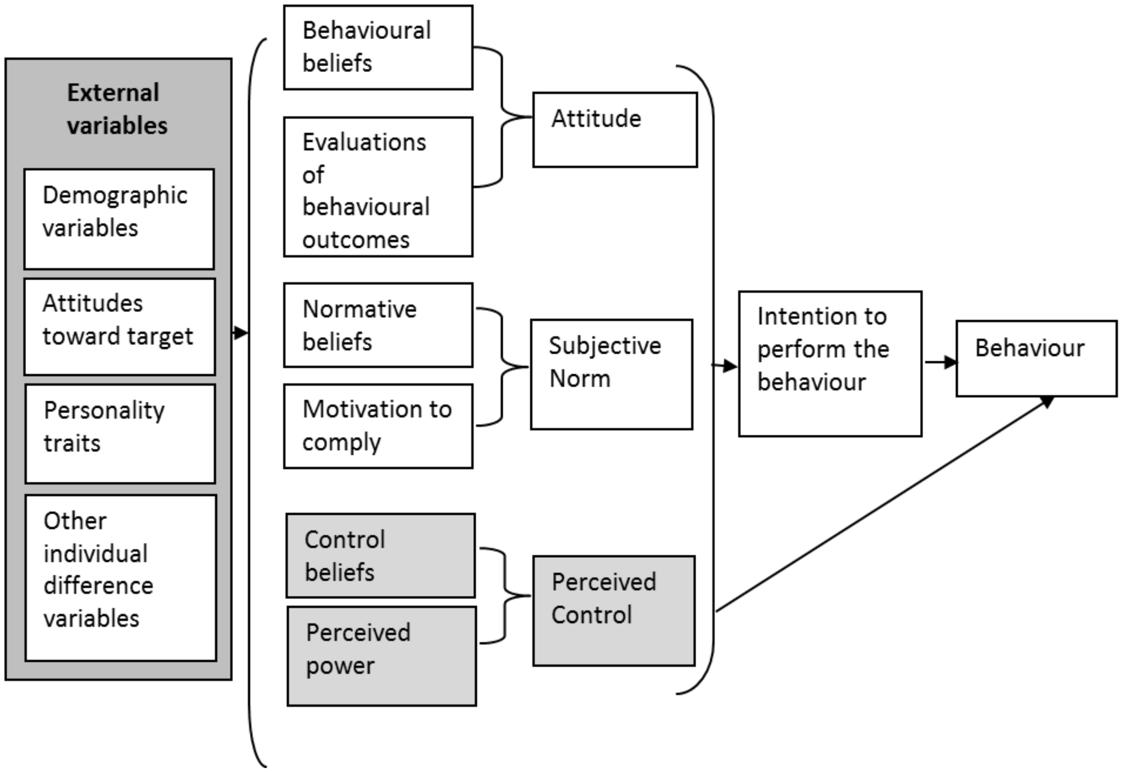

Figure 3.2. Theory of reasoned action and theory of planned behaviour. Adapted from Montano [296]

*Note: Upper unshaded area shows the Theory of Reasoned Action; entire figure shows the Theory of Planned Behaviour

Other factors, including demographic, personality, attitudinal, individual differences variables and environmental characteristics', are assumed to operate through the model constructs, however they do not independently contribute to the likelihood of performing a behaviour [296]. Thus, certain demographic groups may be more likely than others to engage in a behaviour because there are demographic differences on the proximal variables (e.g., attitudes). It is important to investigate and understand how beliefs may differ across various groups based on these external factors, as it may be useful to segment the population and then to design different interventions for different segments if there are clear differences in belief patterns [296,299,300].

Numerous studies utilising the TRA and TPB have been summarised in several meta-analyses and reviews, [144,300-307] and shown to explain a significant amount of variance in behavioural intention and to explain and/or predict a number of different behaviours (e.g., physical activity, smoking cessation, or dietary behaviour). Although the TRA and TPB have been criticised, [308] based on whether correlational results can explain behaviour, many effective behaviour change interventions and various published intervention studies have shown that changing TRA/TPB related constructs has led to significant behavioural change [304,309,310].

To date, only a few reviews, [121,122,127,311] have specifically focused on preventive behaviours, and often these reviews did not evaluate the robustness of findings when TRA and TPB (including other BSSTM) were applied. Nonetheless, studies that converge on the use of the TRA and TPB have been conducted in various injury contexts (e.g., motor vehicle injuries [312-315], bicycle injuries [263,282], childhood injury and parental behaviours [279,316,317]), and a further synthesis of such research (and other emerging studies) would appear fruitful in the future to assist ground the focus of behavioural science in the injury prevention field and move it forward in the right direction.

In applying the TRA and TPB to sport injury prevention, only four studies have been conducted utilising these theoretical underpinnings [127]. In the early 1980's, Rosen, Johnson, Lefebvre and Pope [221] used what was termed, the behavioural intention model (otherwise known as TRA) and were interested in understanding the determinants of a skier's failure to obtain an adjustment of release bindings (behavioural risk factor) to reduce the risk of lower limb equipment related injuries. They were specifically interested in predicting which skiers would be most likely to adjust their own release bindings or to take them to a professional binding mechanic for adjustment.

As part of a wider study, participants for this study [221] included 160 skiers in the Sugarbush North ski area of Vermont during the 1979-1980 ski season. Injured skiers who presented at a ski injury clinic at the base lodge (either personally or brought by ski patrol) were included, in addition to non-injured skiers who were selected on the basis of a random number table as they approached the base lodge (either in ski's or from the parking lot). The criterion for selection of skiers was that they were using their own skiing equipment.

A questionnaire was developed specifically for the context of skiing and binding adjustment. Elicitation interviews were conducted to identify salient consequences of binding adjustment and important individuals who might influence a skier obtaining binding adjustments. Skiers who were waiting in a lift-line were approached and asked to "identify the pros and cons of binding adjustment by a professional binding mechanic and by the skier themselves" (attitudes- to identify salient outcomes of performing the behaviour) and "identify individuals who think that they should have their bindings adjusted" (social norm- to identify salient referents). The elicitation interviews provided the questionnaire content, and measures of behavioural attitude and subject norms were developed regarding binding adjustment by a professional or the skiers themselves.

Although elicitation interviews are beneficial and a major strength of the TRA and TPB, [307] the explanatory power of the TRA used in this study [221] to understand skier's binding adjustment-preventive behaviour may have been compromised due to conceptual and methodological concerns. For example, limited participants' used in the elicitation sample resulting in possible lack of beliefs identified corresponding and/or representative of this skiing population. Furthermore, the procedures for elicitation interviews and the measures used (i.e., type of questions posed to skier's) may not have captured a full understanding of the psychosocial and cognitive influences (i.e., a range of reasons "behavioural, normative and control beliefs" for skiers obtaining professional binding adjustment or not) regarding binding adjustment.

The results of this study [221] indicated that 89 skiers obtained professional binding adjustment, and 71 skiers did not obtain professional binding adjustment. One hundred and twenty nine skiers also reported that they completed the binding adjustment themselves, with 31 skiers specifying they did not self-adjust their binding. Skiers were more likely to have their bindings adjusted if they believed that negative outcomes could be avoided with properly adjusted bindings (attitude toward the behaviour). The two stated salient beliefs in this sample of skiers were that adjustment can (1) prevent a ski injury and (2) prevent an inadvertent release.

Skiers were also more likely to have their bindings adjusted if they thought that knowledgeable individuals would favour taking this action. This suggests that skiers are influenced by what ‘experts’ knowledgeable about ski safety think (subjective norm). On the basis of this, the authors [221] suggested it might be possible to increase the rate of professional binding adjustment and decrease the rate of self-adjustment if respected groups within the ski community such as ski shop personnel, ski magazine writers, ski area operators, and medical personnel promoted proper binding care more rigorously. To encourage more skiers to have their bindings adjusted by a reliable binding mechanic, the authors also suggested it might be necessary to provide skiers with more factual information about the relationship between release settings and ski accidents.

This study conducted by Rosen et al. [221] also has a number of other limitations that should be noted. Firstly, the cross-sectional nature of the study, although often used to test the TRA, may have provided a poor prediction and understanding of previous behaviour because the time order of motivations and binding adjustment behaviour could not be discerned. In fact, cross-sectional studies usually only measure behavioural intentions which are not actual behaviour, which is an essential component of the model. Longitudinal studies have been recommended to enable researchers to learn if factors that predict behavioural intentions will actually predict behavioural change [296]. It is noted, that although the authors differentiated between skiers’ binding behaviours (professional binding or not), the consistency between behavioural intentions and the actual behaviours was not necessarily established. Rosen et al., [221] also did not present a detailed analysis of the “cognitive structure”, in terms of beliefs and evaluations of underlying attitudes and subjective norms related to binding adjustment. This has also been a criticism of previous injury prevention research (e.g., road safety research [312,313]). Furthermore, the sample size and geographical location of participants may also limit generalisation of study findings, as other populations (or locations) may have differing beliefs. Exploring further salient beliefs and other factors that influence binding behaviours from other models (e.g., HBM, SCT) and the use of multi-item scales (rather than one-or-two-item scales) may be beneficial to understand the dynamics of preventive binding adjustment behaviour and enhances the application of behaviour change strategies to ensure appropriate safety behaviour among skiers. Elucidating additional factors in this respect would however have to be balanced against increasing the number of questionnaire items to be completed by skiing respondents.

More recently, Deroche , Stephan, Castanier, Brewer and Le Scanaff [241] examined the contribution of the social cognitive antecedents from TPB variables, and both perceived susceptibility to/perceived severity (HBM constructs) of, skating injury on the PPE wearing intention of adult skaters. Although studies in other areas have investigated or tested the comparison of theories (e.g., [263,318]) or extended theories with constructs from other models, (e.g., past behaviour [319], moral norms [297,303], anticipated affective reactions [315] and self-identity [320]), this study is the first step toward the development of an integrative model to characterise the psychological factors influencing the decision making processes that lead adult skaters to use safety PPE.

In this study, a sample of 270 skaters were initially contacted during a roller hiking event in the Paris (France) metropolitan area [241]. A total of 181 skaters, with a mean age of 30.91 (SD=10.44) years completed a questionnaire prior to commencing their hike to depict hypothesised psychological factors in relation to intentions about PPE use. A questionnaire was developed using single-response scales to assess each component of the TPB (intentions, attitudes, subjective norm, and perceived behavioural control) and perceived risk (perceived susceptibility and perceived severity).

Accordingly, it was first hypothesised that the TPB components would contribute to intention formation about PPE use [241]. Based on hierarchical regression analyses, this hypothesis was in part supported, with a significant contribution of instrumental attitude (overall evaluation of behaviour) and subjective norm predicting intentions to use PPE. Thus, the more adult skaters considered PPE as useful (instrumental attitude) and believed that the other skaters think they should not skate without safety gear (i.e. subject norm), the more they intended to wear PPE. However, the entire structure of the TPB was not supported by the data. Instrumental attitude (i.e. seeing PPE as useful) had a much stronger relationship to PPE wearing intention than emotional attitude (i.e. feeling ridiculous). The subjective norm component was less influential on adult skaters' intention to wear PPE than instrumental attitude. Similarly, PBC was not linked to PPE wearing intentions among adults when it considered the other TPB variables.

This study of adult skaters indicates that the inclusion of perceived susceptibility and perceived severity within the TPB add a small but incremental portion of the variance in the prediction of PPE wearing intention [241]. In addition to positive attitudes about PPE use, the more skaters who perceived themselves as being susceptible to injury and considered that skating injury could be severe, the more likely they would be to form an intention to use PPE. The results suggest that threat perceptions (perceived susceptibility and perceived severity) are important contributors to health-related intentions within the TPB. Thus, threat perceptions need to be recognised as important factors in relation to PPE use. Indeed, the TPB has been criticised for not including emotional, fear arousal or elements such as perceived susceptibility and have recommended for the purposes of intervention development that the TRA and TPB might need to be supplemented with the HBM or another theory [296].

Furthermore, an interesting finding in this preventive skating study by Deroche et al., [241] relates to the subjective norm component not remaining significant in predicting skaters' intentions to wear PPE when perceived susceptibility and perceived severity were added into the regression analysis. This confirms the importance of skaters' "personal consideration" over "perceived social pressure" in adult decision-making process about safety PPE use. Thus, the personal beliefs of skaters about their chances of experiencing an injury (perceived susceptibility), and their beliefs about the seriousness of sustaining an injury and its sequelae (perceived severity) influenced skaters intentions to use PPE significantly more than their beliefs about what important others think they should do ("most of the skaters think I should not skate without safety gear”). The use of single items scales to measure the subjective norm construct and no apparent use of elicitation interviews to explore important salient others may be a limiting factor in the resultant finding of the subjective norm construct. It may also be that in this study the subjective norm items may need to be reconceptualised. It has, indeed been argued, in published reviews that this construct needs to be expanded [303,321-323]. This latter point could lead to deferral of the results of this study [241] and the need to explore subjective norms in more detail prior to attempting to develop strategies to influence behaviour change, and thus avoid inherent failures and/or enhance the effectiveness of preventive measures to achieve reduced injury outcomes.

Targeting an adult population, Deroche et al., [241] suggested that in addition to affecting TPB components, especially instrumental attitudes (i.e., it would be useful to wear PPE while skating) toward PPE use, interventions should attempt to increase the strength of beliefs, such as perceived risk of severe injury, to promote preventive behaviours. As risk communication has been found to be effective in influencing threat perception, [324] media campaigns and other injury countermeasures in this direction seem promising and have the potential to help prevent injury among adult skaters.

Further research however will need to be conducted in other sports to ascertain if the TPB (and its extensions) found in this study can be used to understand the determinants of various preventive behaviours and applied in developing, implementing and evaluation interventions to prevent sporting injuries in other contexts. The design limitations of this study include the use a cross-sectional design, no elicitation phase being conducted, sample size, and targeting a few beliefs using single response items which may not be effective if they represent a small set of beliefs affecting intentions.

In summary, the research conducted by Deroche et al., [241] demonstrated that the TPB offers considerable potential in predicting and explaining PPE wearing intentions and behaviour. Further, it indicates that threat perceptions (perceived susceptibility and severity) may help to account for the variance in PPE beliefs and attitudes that ultimately determine the decision to engage or not to engage in PPE use whilst in-line skating. Limitations and relevant findings of this study, and other TPB research will need to be taken into consideration when conducting future research.

Finch, Donohue and Garnham [123] reported to use TRA principles in the design of a survey to describe the general safety attitudes and beliefs of 103 elite junior AF players. All players from a convenience sample of four Victorian Football League (VFL) metropolitan clubs and two country clubs were invited to participate. A questionnaire was developed and administered to players at a team training session at the commencement of the 1999 playing season. Although the authors, made reference to the use of the TRA for questionnaire development, the dimensions labelled within the methodology are actually more specific to the TPB.

This study [123] found that 6% of players believed it was safe to play with injuries and 58% reported they would be willing to do so. Over 80% of players reported they would risk playing with an injury if they thought their chances of being selected in the AFL draft would be affected if they did not play. About 70% of players believed injured players would likely suffer later problems if they continued to play with injuries. Local club coaches were perceived by players to provide significantly more support to injured players than VFL U18 coaches or school coaches. Administrators at VFL U18 level were however perceived to be more supportive than club level administrators. Support from team mates when a player was injured was shown to be lower at school than VFL U18 or club level. The level of support from family was perceived to be high in all settings. Many players reported that they felt pressured to play when injured; this was particular associated with school football. Feelings of isolation were reported by players when injured, particularly at the VFL level. Across all settings most players also reported not being included in club activities when injured.

From a model perspective, these findings should however be interpreted with care because the manner in which the authors report the findings makes it difficult to examine the relationships obtained between TPB dimensions and actual safety behaviour. In addition, such variables as “attitude toward the behaviour”, “subjective norms” and “perceived behavioural control” appear to have not been operationalised in the traditional fashion [325]. For example, some items that appear to be reported as the "attitude toward behaviour" construct seem to relate more to the perceived severity construct from the HBM, [242] the behavioural component of items was also not clearly indicative of a specified behaviour, rather different behaviours in general were noted.

Furthermore, the subjective norms construct is usually taken to denote a person's perceptions that significant/important others think they should or should not perform the behaviour and the person's motivation to comply with what important others think or feel [297] (i.e., people who are important to me (e.g., coach, parents), think that I should wear a helmet to prevent injury and doing what the (e.g., coach, parents) thinks is important to me). Dichotomisation of this variable in the discussion of findings appeared to be that of social support used, which is more often referred to as an individual's relationship with others that provide resources for coping or the comfort, assistance and information one receives through formal and informal social interactions [326,327]. For example, a football player feels they can confide in or rely on a coach to provide help and show concern when they are injured to protect against any harmful effects to their wellbeing. This implies a perception of assistance in performing a behaviour, and is clearly not the true definition of subjective norms according to that of Ajzen and Fishbein's [297]. It is however, focal to note that social support is nevertheless an important dimension and is often referred to within the social cognitive theory (see SCT Section 3.2.4) [244,328] as an important determinant and influence of behaviour, and has been widely accepted in physical activity research [323,329-332] and other domains of behavioural and social psychology [316,333-340,340]. Furthermore, sport and exercise psychology research [331,332] has indicated that social support has a stronger influence than subjective norms in predicting physical activity intentions. Indeed, some researchers [332] have suggested social support should be a permanent figure within the TPB, or even used instead of the subjective norm construct within the context of understanding and predicting exercise-related behaviours.

It has also been communicated within the broader TRA/TPB literature that the subjective norms construct needs to be expanded in definition and that a reconceptualisation of the mechanism by which normative pressure is exerted is required, as is it fails to capture important facets of social influence [303,320,322,323]. Extensions of the subjective norm component in the TRA/TPB incorporating self-identity, social identity, group norms, family social support, friend social support, and social provisions (e.g., guidance - advice or information; reliable alliance – others are counted on for tangible assistance; reassurance of worth – recognition of one's competence; opportunity for nurturance; attachment – emotional closeness; and social integration – sense of belonging to a group) have been explored and shown to integrate well within the TRA/TPB model in understanding intentions and behaviour [303,320,322,323,341]. Further investigation of sources of social influence is warranted in the sport injury prevention environment. It was also acknowledged by Finch et al [123] that negative attitudes and beliefs should be addressed in any comprehensive injury prevention strategy aimed at the elite junior players, further interpretation of and recommended evidence-based behavioural strategies related to model components would have been useful from a practical standpoint, and future authors should be urged to provide such details [306].

In 2008, Iversen and Friden [111] conducted a prospective pre-post design study to address modifiable risk factors to prevent knee injuries (specifically anterior cruciate ligament (ACL) injuries) in basketball. They used the TRA/TPB as the framework to characterise female high school basketball players' and coaches' injury knowledge, attitudes, and behaviours (or practices) (KAB) regarding ACL injury risks and injury prevention techniques. In addition, the effectiveness of an educational program on players' and coaches' knowledge about the role of the ACL and ACL injury risk, attitudes towards injury prevention and the use of injury prevention practices was examined. The authors hypothesised that improved knowledge about the function of the ACL and ACL injury risk and instruction in injury prevention practices would influence attitudes toward injury risk and, in turn, impact the practices of players and coaches.

Coaches, the athletic directors and principals of eight selected high schools in the Massachusetts South Coast Conference (SCC) were contacted to be involved in the study. Five high schools agreed to participate. A varsity and junior varsity team from each school (10 teams in total) participated in this study. One hundred and thirty female basketball players, with a mean age of 16.2 years (range 14.1-18.8), and 12 coaches were recruited and followed throughout 8-weeks of the basketball season.

Players and coaches completed a baseline questionnaire during pre-season training to ascertain their KAB about ACL and injury prevention techniques. The KAB questionnaire was developed based on the TPB and consisted of three sections: knowledge (anatomy, function, and ACL injury risk factors); attitudes and beliefs (towards ACL injury risks and prevention); and players' and coaches' practices via self-report of ACL injury risk prevention techniques. Players also completed the Knee Injury and Osteoarthritis Outcome Score (KOOS) questionnaire, a previously validated questionnaire [342,343], to assess knee function as it relates to knee pain, knee symptoms, and sports and recreation. Furthermore, players were videotaped to determine the percentage of correct two footed flexed knee landings performed per player during games.

Following the completion of the baseline questionnaire and videotaping, players and coaches participated in a 45-minute educational and skill-based intervention on the anatomy and function of the knee and the ACL, risk factors for ACL injuries, and risk reduction techniques. This intervention incorporated demonstration of exercises and techniques by the researchers, [111] and players were provided with the opportunity to practice the injury prevention techniques, including a series of stretching (e.g. hamstring, quadriceps stretches), strengthening (e.g. forward/backward lunges, diagonal lunges) and jumping (e.g. bounding, wall jumps) drills and techniques. It was ensured that all players performed the exercises and drills appropriately. Players and coaches were also provided with handouts illustrating pictures of proper technique and the description of proper positioning for each exercise to reinforce learning and serve as a resource.

The KAB and the KOOS questionnaires were re-administered at post-intervention (approximately 8 weeks following the intervention) to assess changes in self-report knowledge, attitudes, and behaviours, and players' knee function. Videotaping of two footed flexed knee landing was also performed post intervention, with comparison of landings undertaken from pre intervention.

The findings [111] showed that the program was well received by both players and coaches. Players' average scores on baseline knowledge regarding knee anatomy and function of the ACL was 57.3 percent. There was no significant difference between players with or without a prior knee injury. Most players (73.5%) reported positive attitudes towards the use of ACL injury prevention techniques and an average of 58.4% reported the use of ACL injury practices. Video analysis of landing techniques indicated that the 48% of players demonstrated proper two-footed flexed knee landing techniques. Coaches, at baseline, scored an average of 68.8 on the knowledge scale and demonstrated positive attitudes towards ACL injury prevention techniques (mean score 85.6). The average self-reported use of injury prevention practices during training was 61.1 (range 41.4-97.0).

Knowledge about the ACL and risk factors for ACL injury increased significantly at post- test assessment, however there were no significant changes in attitudes toward injury risk or self-report preventive practices. Observed use of two-footed flexed knee landing during the game improved during the study, however there was not a strong correlation of self-report use of preventive practices and observed use.

Changes in knowledge, attitudes and practice varied by school. Coaches, who scored higher on the ACL knowledge scale, reported more favourable attitudes toward ACL injury prevention techniques and practices. Their players also scored higher, on average, on the post-test assessment. One school demonstrated negative changes on the post-test among players, indicating less knowledge and use of prevention practices. Their coach was the one who scored the lowest on the knowledge, attitudes and behaviours components.

Iversen and Friden [111] noted “a unique component of the program was the development and use of theory-driven educational curriculum and outcome measures” (p.6). It was unclear from the paper, however, that TRA/TPB theory as stated was appropriately used or how it was used as a framework. The authors [111] provided no information on educational curriculum development, nor did they operationalise constructs central to the model. Rather, they appeared to only examine mediating variables, which is likened to the stated hypothesis that increases in *knowledge* would influence *attitudes*, and in turn preventive *behaviours*. It was however found that this predicted hypothesis was not supported and other important factors within the TRA/TPB or other theories that were not considered in this research study, may need to be explored.

The use of education principles and skills promoted in this ACL preventive intervention [111] was argued to be effective in being readily integrated into practice drills, as the training program was readily embraced by coaches and players and it did not prove to be problematic for coaches to implement. The authors concluded [111] that coaches were a key factor in reinforcing injury prevention principles throughout the season, which was somewhat supported by the results. Specific details about implementation components and issues were not reported however. Thus, it is difficult to understand “why” and “how” this preventive program could be adopted, implemented and maintained by basketball coaches and female basketball players’ based on the published paper.

Other limitations of the Iversen et al., [111] study include no indication of an elicitation phase; the lack of a control group; the potential for type II error (program or intervention is considered not efficacious) due to the low power for change in attitude and practice sections of the KAB; and program intervention being limited over a period of eight weeks. Implementation and dissemination issues also did not appear to be formally evaluated and further follow up and reinforcement may have been required by researchers, in addition to other behaviour change strategies that may have influenced change. Although it is difficult to identify the precise methods of intervention delivery and difficulties experienced in the field, the use of both educational and skills based strategies are commended, however it is worth noting that these methods should be implemented with rigour and a sound evidence base. For example, educational strategies have been criticised in the past due to a lack of understanding the determinants of behaviour, it appears in this case that determinants of behaviour may not have been fully explored, as mentioned *a priori*, thus it could be argued based on the hypothesis that knowledge alone cannot change behaviours, behaviour is much more complex. Also, although it was mentioned that the coach was a key factor in reinforcing preventive practices, evaluating leadership effectiveness with the delivery or instruction of the program would seem to be important in this study, as this could be a major factor in the change process.

Further work is required to develop and evaluate this intervention and other sound theory-based interventions to encourage preventive landing training given the vulnerability of female athletes and the lack of knee injury prevention education and skills based training in high school within the USA. This also needs to occur in other populations, sports and countries alike.

3.2.3 Attitude-social influence-self efficacy model

The Attitude-Social influence-self Efficacy (ASE) model originated from the TRA/TPB, [344-346] and has been used to understand and explain various health and preventive behaviours [317,347,347,348]. It describes three major determinants influencing someone’s motivation or intention to engage in particular health behaviour, namely attitudes, social influences and self-efficacy. The model assumes that distal factors, such as psychological, biological, social and cultural factors influence behaviour through the major determinants, and this, in turn, influences behaviour [344-346]. It later incorporated insights of various other theories, such as the social cognitive theory (SCT), [328] transtheoretical model (TTM) [349] and the Precaution Adoption Process Model (PAPM) [350] and resulted in an integrative model explaining motivational and behavioural change (Figure 3.3) [344-346].

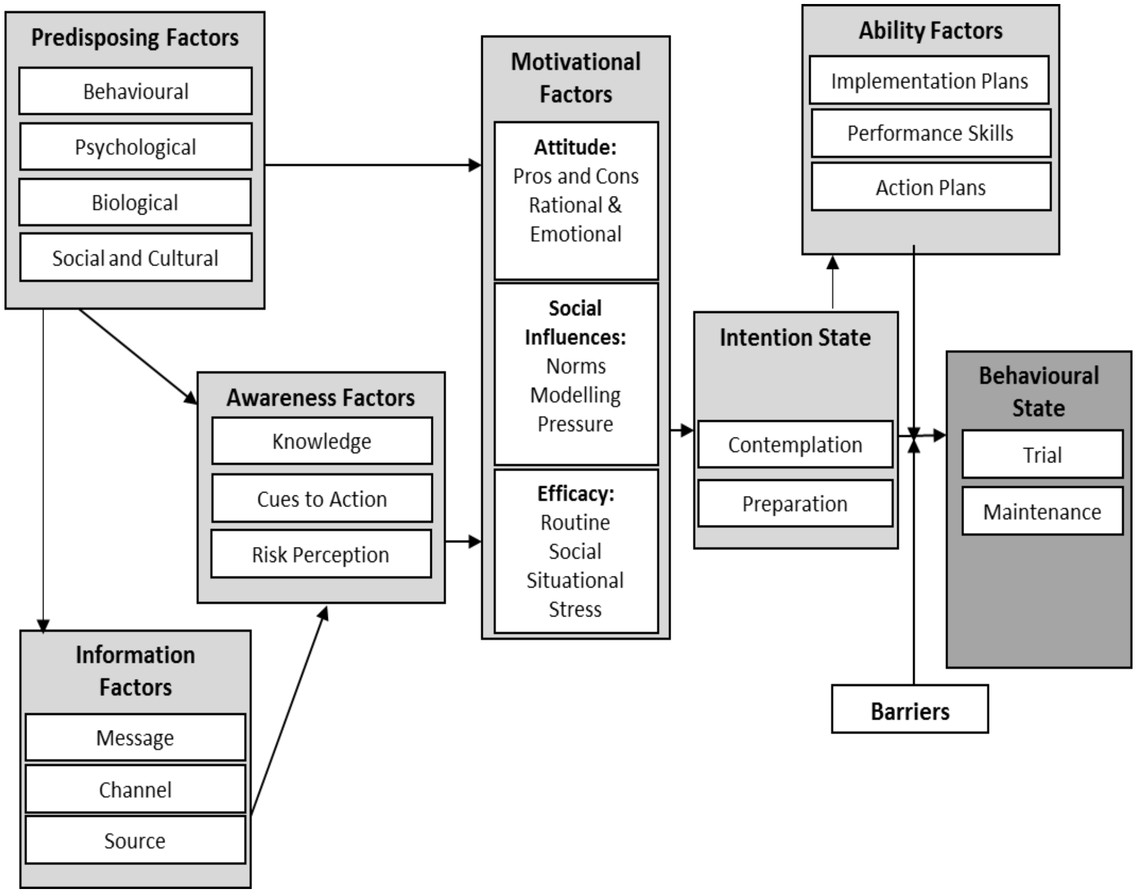

Figure 3.3. ASE model – an integrated model for change. Adapted from [348]

The model states that behaviour is the result of an individual's intentions and abilities. An individual's intentions can range from no intention, to change (precontemplation), to intention to change the behaviour (preparation). An individual's abilities and environmental barriers determine whether their intentions will be realised. Important abilities are plans to implement intentions by specific actions to reach the goal behaviour and actual skills (see, e.g. [328,351,352]. Motivational factors, such as various attitudes, social influences and self-efficacy, also determine a person's intention. Motivational factors are determined by various predisposing factors, information factors (the quality of messages, channels and sources used) and awareness factors (knowledge, risk perceptions and cues to action) [344-346].

De Nooijer, De Wit and Steenhuis [157] applied the ASE model to investigate how young Dutch skaters protect themselves against injury and what factors predict the use of PPE in order to develop campaigns to increase their safety behaviour. The target group for the study were Dutch children, aged 9-13 years, who had tried to skate at least five times. Of the 100 schools in the Netherlands approached to be involved in the study, 15 schools agreed to participate. A questionnaire was developed to measure behavioural and social determinants of skating protective behaviour and 1200 questionnaires overall were sent to identified schools and completed by children during school hours.

The questionnaire was developed based on the ASE model and although not all constructs of the model were tested, the authors incorporated measures such as protective behaviour ('how often do you wear protective equipment'–helmets, wrist guards, elbow and knee pads), intention to wear PPE, attitudes towards wearing PPE, social influences (modelling of friends, social norms of friends and parents, and social pressure from parents), self-efficacy, demographic items (e.g. age, gender), and questions referring to skating experience, whether they owned their own skates, and what type of skater they believed they were (recreational or performance). A total of 978 (82%) questionnaires were returned, with 872 skaters included in the final analysis.

Overall, PPE was not often used (36% used wrist guards, 28% used kneepads, 14% used elbow pads, and 5% used helmets) by young Dutch skaters. No differences were found between male and female students, with the exception that more females generally used wrist guards more so than males. Multiple regression analysis found the use of PPE was strongly predicted by social influences (modelling and social pressure), self-efficacy expectations and intention. Age and frequency of PPE use were also shown to be significant predictor variables associated with PPE use, but only accounted for 5% of the variance in PPE behaviour.

De Nooijer et al., commented on the implications of the findings, indicating that skaters (aged 9-13 years) in this sample were particularly motivated by what they observed in their environment (modelling of friends) and what they were told by their parents (social pressure) [157]. The social norms construct, however, was not a significant predictor. De Nooijer et al., also suggested the reasons for this lack of significance may be related to age factors and developmental stage of the children (9-13 years) in this sample. It may be that social norms are more implicit or “unspoken” in influencing PPE use compared to other social influence constructs such as modelling and social pressure which may be more direct or explicit in reality considering the sample represented and development stage. Though it also may be indicative of similar social norm construct issues (e.g. operationalisation of construct) as mentioned previously in this review [123,241].

A number of strategies were recommended by the investigators [157,241] to develop programmes to prevent injuries from in-line skating, including: (1) educating children about the risks of skating, the benefits of using PPE and about how to manage barriers that may interfere with PPE use; (2) facilitating automatic or habitual use of PPE by using “cues to action” to facilitate PPE use, such as keeping PPE next to skates with the idea that PPE will be put on automatically when children collect skates or put them on; (3) educating or influencing parents to observe and reinforce their children’s PPE use; (4) making PPE mandatory during competitions, organised skate tours or playgrounds near school; (5) shops that sell in-line skates facilitating the purchase of PPE with in-line skates (i.e. providing financial incentive or reduce prices when PPE is sold together may increase sales); and (6) manufacturers of in-line skating PPE developing comfortable and attractive helmets and other equipment.

Although these recommended strategies may be appropriate, some of the recommended strategies were not based on direct findings from this study, and were based on either the full conceptualisation of ASE model itself, an ecological framework, the practical experience or foresight of the authors, or even “what” strategies may have worked in other studies to change behaviour. This is potentially problematic and could lead to failure of changing behaviour (e.g. PPE use) and/or enhancing the adoption of an intervention due to not recommending strategies based on identified determinants of PPE behaviour in this population. Further understanding of the determinants of PPE protective behaviour may need to be explored in this context to fully capture the essence of the ASE model, in turn, to develop strategies based on the identified determinants, and to go one step further in testing the efficacy/effectiveness of such strategies in influencing use in practice settings. Moreover, a careful analysis should be conducted of the preventive behaviour and population studied to determine which of these components are most important to target to promote the preventive behaviour. Very different strategies may be needed for different preventive behaviours, as well as for the same preventive behaviour in different settings or populations.

Other limitations of this study [157] include the use of self-report, the cross-sectional nature of the study, and specific geographical location in Europe which may limit the generalisability of results in other social and cultural sporting environments.

3.2.4 Social cognitive theory

Social Cognitive Theory (SCT) seeks to provide a comprehensive understanding of both why and how people change their individual health and preventive behaviours and the social and physical environments that influence them [328,353]. The SCT has a strong foundation for action-oriented research and practice, using a broad range of approaches to modify diverse behaviours [328,353]. Although there has only been limited use of the SCT in sport injury prevention [127,138] its utility has been supported for intervention development and implementation in other areas of injury prevention [353,354] and generally has predominated in the area of health promotion with numerous successful outcomes [354,355].

Most behavioural and social theories focus on the individual, social and environmental factors that determine individual or group behaviour (for example, barriers, rewards and punishments, and social norms portrayed in mass communication) [354]. The SCT posits that human behaviour is the product of the dynamic interplay of personal, behavioural and environmental influences [244,328].

As Figure 3.4 shows environment, behaviour and person are understood to be dynamically interrelated, a concept termed reciprocal determinism. Accordingly, the *environment* represents the broad physical and social environment which set the stage for behaviour. The environment includes: (1) physical aspects, such as resources, equipment and facilities, as well as policies, programs and enforcement practices that influence behaviour; and (2) social influences, such as those influences by close others and the influence of general social norms. *Behaviour* refers to actions, either intentional or not. *Person* refers to the individual cognitive, affective (i.e. emotional) and biological self. The environment influences behaviour by providing context, opportunity, and reinforcement, which are "processed" by a person, such as a squash player or athletic coach, and acted on. Through action, behaviour influences the environment, and this experience provides information that is processed and stored cognitively and emotionally by an individual. In essence, not only does the environment affect behaviours, but behaviours also affect the environment. The constant and dynamic reciprocity of these three components makes them integral, such that a change in one component is associated with a change in others [353].

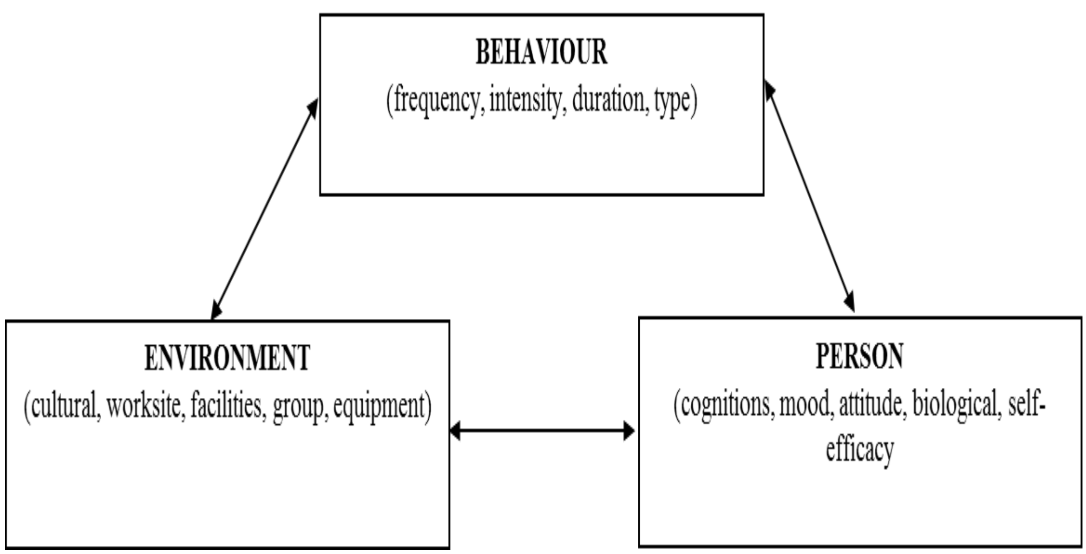

Figure 3.4. The concept of reciprocal determinism in the social cognitive theory. Adapted from [244,328]

In Bandura's 1977 [249] framework, expectations of personal efficacy were based on four main sources of information: performance accomplishments, vicarious experience, verbal persuasion, and emotional arousal. He later modified these slightly to mastery experiences, social modelling, social persuasion, and physical and emotional states. Mastery experiences are considered the most effective means to developing a stong sense of self efficacy, while failure undermines it. Social modelling refers to the likelihood that if people see others like themselves succeeding at something through sustained effort, they will come to believe they too are successful. Social persuasion strengthens people's belief in their efficacy by encouraging them to believe they have what it takes to succeed. Physical and emotional states also help people to judge their capabilities. Emotions such as fear and anxiety, and physical states such as fatigue, provides cues as to the likely success or failure of the outcome. People also read these signs of deficiency, which can diminish efficacy expectations. These sources have also been expanded by others to include imagery and other sources of learning in the context of sport (e.g., learning efficacy, preparatory efficacy, competitive efficacy).

Bandura [524] considers efficacy expectations to be central in determining people's choice of activities, the level of effort they would expend, and how long they would persist in the face of difficulties. He argued that an individuals level of motivation, affective states and actions are based on more on what they believe than what is objectively true. Therefore, individuals belief about their capabilities are a better predictor on behaviour than their actual capabilities. People with high self-efficacy regard difficult tasks as challenges rather than threats. They set high goals and stay committed to them. In the face of obstacles they try harder. They are motivated, optimistic and not especially vulnerable to stress or depression. People with low self-efficacy, however, avoid difficult tasks, and have low aspirations and weak commitment to their goals. In the face of difficulty, they dwell on the obstacles and their personal deficiencies, and give up. They easily fall victim to stress and depression.

SCT was based on agentic notion that individuals are instrumental in their own development and they are the producers as well as the products of social systems [524]. In 1977 Bandura expanded his conception of human agency to include collective agency. Arguing the people do not live in isolation; they have shared beliefs and work towards common goals. According to SCT, factors such as socio-economic positions, education, occupation and family structures do not affect human behaviour directly. They affect it to the extent that they influence people's aspirations, self-efficacy, personal standards, emotions and other self-regulatory mechanisms [524].

The SCT specifies a core set of determinants of behaviour, the mechanism through which they work, and the optimal ways of translating this knowledge into effective health and preventive practices (see Figure 3.5). Bandura [244] posits the core determinants include:

- *knowledge* of health risks and benefits of different health practices;
- *outcomes expectations* about the expected costs and benefits for different health habits; thus even when individual's believe they could perform a behaviour, they had to believe that performing it would be beneficial before they were likely to do it. As figure 3.5 shows, which Bandura applied to health behaviours, outcome expectations include the positive and negative impacts of the health behaviour and the accompanying losses and benefits, as well as social approval and disapproval, and positive and neagative self-evaluative reactions (such as self-satisfaction or self-worth) to one's own health behaviour and health status.
- the health *goals* people set for themselves and the concrete plans and strategies for realising them – while long-terms goals set the direction for change, short-term achievable goals keep people focused and help them succeed in the here and now.
- the perceived *facilitators* and social and structural *impediments* to the changes they seek – obstacles to successful performance of health behaviour changes include bad weather, emotional responses such as depression or anxiety, fatigue, work pressure, and competing priorities.

- *perceived self-efficacy* that one can exercise control over one's health habits – is central determing individual's response to obstacles: people with high self efficacy keep going, while people with low self-effiacy give up quickly.

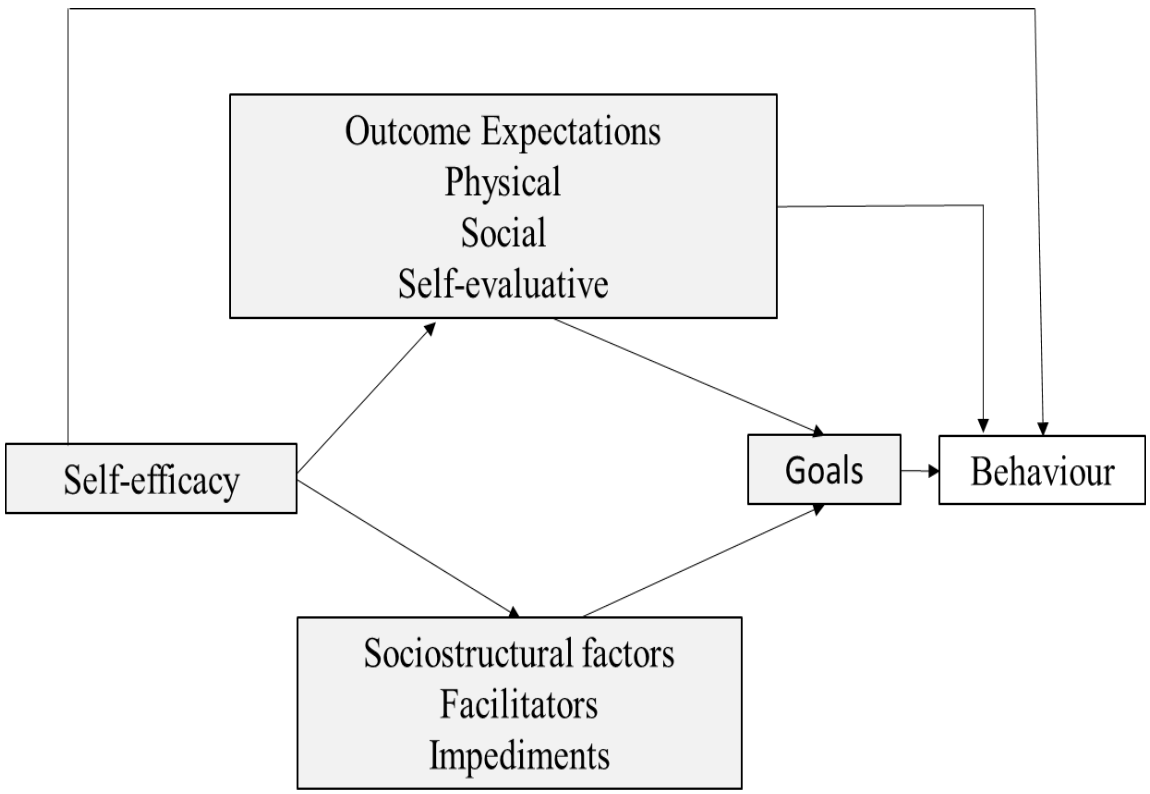

Figure 3.5. The impact of self-efficacy on health habits, both directly and through its influence on goals, outcome expectations and perceptions and sociostructural facilitators and impediments. Adapted from [524]

Table 3.1 defines the key concepts of SCT. These can be grouped in five categories: (1) psychological determinants of behaviour, (2) observational learning, (3) environmental determinants of behaviour, (4) self-regulation and, (5) moral disengagement.

Table 3.1

Key Concepts of the SCT

Concept	Category	Definition
Reciprocal Determinism		Environmental factors influence individuals and groups, but individual and groups can also influence their environments and regulate their own behaviour
Outcome Expectations	1	Beliefs about the likelihood and value of the consequences of behavioural choices
Self-efficacy	1	Beliefs about personal ability to perform behaviours that bring desired outcomes
Collective efficacy	1	Beliefs about the ability of the group to perform concerted actions that bring desired outcomes
Observational learning	2	Learning to perform new behaviours by exposure to interpersonal or media displays of them, particularly through peer modelling
Incentive motivation	3	The use and misuse of rewards and punishments to modify behaviour
Facilitation	3	Providing tools, resources, or environmental changes that make new behaviours easier to perform
Self-regulation	4	Controlling oneself through self-monitoring, goal-setting, feedback, self-reward, self-instruction, and enlistment of social support
Moral disengagement	5	Ways of thinking about harmful behaviours and the people who are harmed that make infliction of suffering acceptable by disengaging self-regulatory moral standards

In 1996, the SCT was used in a sport-related study to describe the use of discretionary PPE among high school athletes and to examine how social and behavioural determinants, consistent with the SCT, influence equipment use by high school athletes [138]. In particular, physical environment factors (school size), social environment factors (coach experience, qualification and training; player/coach ratio), observational learning factors (team usage of PPE); and behavioural capability factors (history of prior injury) that may affect use of discretionary lower limb PPE (e.g., knee pads, shin guards, knee braces and ankle braces) were examined.

The study by Yang et al., [138] was a part of a wider 3-year study conducted between 1996 and 1999 (the North Carolina High School Athletic Injury Study [356]. A total of 100 high schools and 12 sports (divided by gender basis, 6 male and 6 female sports) were involved in this study. Sports included soccer, track and field, basketball, baseball, wrestling, football, softball, volleyball and cheerleading.

At the commencement of each season, a demographic form was provided to athletes and coaches. Athletes were asked to provide socio-demographic details (age, gender, grade, race, height and weight), information about their previous playing experience in all sports, the use of sport specific PPE and previous history of sports injury/ies. Information collected from coaches included demographics, qualifications, certification and training status as well as their experience as a coach. School size was ascertained by obtaining the number of students enrolled at the commencement of the school year, player/coach ratio was computed by the number of athletes in a team divided by the total number of coaches (head coach and assistant coaches) for a team, and team use of PPE was calculated as the number of teammates (other than the athlete) who reported using PPE, divide by the total number of athletes on a the team and then multiplied by 10. The final sample consisted of 13513 students (n=7916 (61.3%) males; 5597 (38.7%) females) and 609 coaches (n=418 (70.2%) males; n=191 (29.8%) females).

Overall, it was found that small school size, low player/coach ratio, high PPE usage by teammates, and a history of prior injury was associated with higher usage of PPE, with the authors [138] suggesting that intervention efforts to promote the use of protective equipment need to target school-level factors and involve peer influence. Based on the conventional approach of defining and measuring SCT constructs by Bandura, [244,328] it appears however that the operationalisation of some constructs (e.g., observational learning) may be construed as inapt or simplistic and may have been better understood utilising other conceptualisations of constructs and methods of data collection. Coach factors explored in this study did not render any association with PPE use, suggesting coach experience, qualifications and training may be more distal factors. Other factors such as coach attitudes towards PPE use, perception of benefits/barriers of PPE, and whether they encourage the use of PPE in their coaching efforts would appear to be important to investigate, these were not however considered in this study [138].

The initial results in Yang et al's., [138] study could potentially be used to target intervention efforts to reduce sport injury among high school athletes. The SCT model, however needs to be tested more fully and in a rigourous manner using appropriate methodology that explores the depth of factors in this context. Different concepts and principles in SCT may also need to be measured (e.g., self-efficacy), identified and then and manipulated (e.g., behaviour change strategies used to influence attitude change or risk perceptions) in systematic experiments replicated over diverse behaviours and populations. For example, further research specific to Yang et al's., [138] study could explore why individual and team factors affect decisions by athletes to use lower extremity discretionary PPE and what roles schools could play to promote usage. Such further research could indicate whether some of SCT concepts and principles are more or less useful or feasible for particular behaviours or types of behaviour change. To improve the degree to which concepts from the SCT and other conceptual models are tested in large-scale evaluations of multi-component interventions, future research should focus more closely on the measurement and analysis of the theoretical concepts that are presumably influenced by a successful theory-based intervention. The SCT could also be used in conjunction with other theories.

3.3 Community Models and Approaches for Intervention

3.3.1 Diffusion of innovation theory

The Diffusion of Innovation Theory (DIT) spans diverse fields and has several components [357,358]. It has been used over several decades to understand the steps and processes required to achieve widespread dissemination and diffusion of public health innovations [358]. Classical diffusion research has its roots in sociology, anthropology, physical geography and education. These early research traditions were however all characterised by a pro-individual, pro-innovation bias and took little account of the wider context (historical, political, ideological, organisational) in which adoption decisions were made or of the unintended consequences of innovations [357-359].

The pro-innovation bias is the implication in diffusion research that an innovation should be diffused and adopted by all target members of a social system, that it should be diffused more rapidly, and that the innovation should be neither reinvented nor rejected. This can lead to lack of recognition of underemphasising the rejection or discontinuance of innovations, to overlook re-invention, and/or failure to study anti-diffusion programs designed to prevent the diffusion of 'bad' interventions (e.g., cigarette smoking) [357]. The end result being a failure to learn important aspects of diffusion. Rogers [357] urges researchers however to recognise that some innovations should be re-invented and others should be rejected and we can learn much from studying these processes.

Another often cited criticism of the model is its pro-individual bias, the tendency to hold individuals responsible for their problems, rather than the system in which the individual is a part of [357]. Whilst some of these issues or biases are still apparent in research, more contemporary research approaches to health promotion and prevention are aimed at community development and long-term social change [358,360]. Moreover, there has been a shift to greater recognition of system- and policy- level determinants of health behaviour in public health and scholars and researchers in any area should be encouraged to not only focus on the individual as the unit of analysis but should also "seek out" causes of social problems and engaging communities to define and solve injury problems.

Until recently, however, there has been little incentive for researchers to consider issues related to wider dissemination and diffusion of effective programs, [358,360] particularly in sport injury prevention [127,173,239]. Government and public agencies are now recognising the importance of diffusion, dissemination and translation [360,361]. Indeed, if public health programs, products and practices (e.g., injury prevention programs and interventions in sport) are not widely and effectively disseminated, they will not achieve the potential impact to improve the public's health.

Diffusion is defined as the process by which an innovation is communicated through certain channels over time among the members of a social system [357]. Dissemination is the planned, systematic effort designed to make a program or innovation more widely available to a target audience or members of a social system [357]. The first component of the theory is that adoption occurs in stages. In most applications, five stages are proposed: (a) gaining knowledge about the innovation, (b) being persuaded to use the intervention, (c) deciding to try the innovation, (d) deciding to implement the innovation, and (e) confirming the decision, including integrating it into one's routine. When applied these adoption stages are often referred to as dissemination, adoption (combining persuasion and decision), implementation, and maintenance or sustainability.

A second premise of the diffusion theory, broadly applied, is that some innovations diffuse quickly and widely, whereas others are weakly or never adopted, and others are adopted but subsequently abandoned. Rogers [357,359,362] and others (e.g., [363,364]) have identified key sets of variables that can explain different outcomes in relation to adoption, including: (1) characteristics of the innovation; (2) characteristics of the adopters; and (3) features of the environmental context or setting.

"Characteristics of the innovation" include core attributes, for which a strong body of evidence exists [357]. These attributes have been associated with the adoption of preventive programs [357,364] and include relative advantage (is the innovation better than what was there before?), compatibility (does the innovation fit with the intended audience?), complexity (is the innovation easy to use?), trialability (can the innovation be tried before making a decision to adopt?), and observability (are the results of the innovation visible and easily measureable?). Other attributes include cost and novelty of the innovation.

Rogers [357,359] has described five adopter categories (i.e. characteristics of adopters) including: (1) innovators, (2) early adopters, (3) early majority adopters, (4) late majority adopters, and (5) laggards. These adopter categories have been proposed to provide a basis to design and implement intervention strategies aimed at particular groups of individuals [357,359]. Although these adopter categories were originally proposed to be used primarily for descriptive and planning purposes, there has been a tendency to use these categories as explanatory or predictor variables of particular behaviours, despite little empirical support for such [357]. Many different features of settings and/or context can influence the diffusion process. Such categories of features can include geographical settings, societal culture, political conditions, globalisation and uniformity. Dissemination of innovations may occur in some settings but not in others.

Sawyer et al., [239] conducted a large, comprehensive pilot study to evaluate coaches' perceptions, assessments and use of a toolkit (Heads Up: Concussion in High School Sports) designed to assist them prevent and manage concussions among high school athletes, prior to a planned national rollout in the United States. The toolkit was developed by the Centre for Disease Control and Prevention (CDC) - National Centre for Injury Prevention and Control, and the study involved development of a dissemination strategy and evaluation of the concussion toolkit, grounded by the use of the DIT.

A sample of 5121 coaches was selected through stratified random sampling of coaches listed in the Clell Wade Coaches Directory in five states (California, Maine, Michigan, North Carolina and Texas) [239]. The toolkits were subsequently mailed to selected coaches, with a postcard reminder sent five days following, which advised that the coaches might be contacted by telephone to participate in a short survey about the toolkit. Computer assisted telephone survey interviews were conducted by trained data collectors approximately one week after deemed receipt of postcards, with a total of 497 completed calls with coaches (response rate=39.3%). The survey included 40-items on demographics of school coaches, school contextual variables, initial attention by coaches to the toolkit materials, coaches' use of or plans to use the toolkit, and coaches' assessment of the toolkit.

Most responding coaches reported that they had used or planned to use the toolkit materials. Eighty-one percent of coaches reported that their school had an existing written plan for preventing and managing concussions and indicated that the toolkit could be used to improve this. Coaches (96%) from schools without a formal "concussion plan" indicated that the kit could be used to develop one. Most coaches assessed the kit as visually appealing, easy to use, and contained appropriate content. There were no significant differences among coaches with differing professional experience or for sports with different injury rates. Among the coaches with other concussion prevention materials, most indicated greater satisfaction with the toolkit.

Among the study's limitations [239] are: (1) low response rates potentially affecting external validity, such as limiting generalisability of results; (2) program implementation with lack of, or no clarity around the specifics of concepts and stages in the diffusion process and important factors in the diffusion process; and (3) study design factors impacting on low response rates affecting external validity.

Another study using the DIT was conducted by Anderson et al., [173] examined the diffusion and predictors of helmet use among 6400 skiers and snowboarders in the Western United States and Canada at various ski areas in 2001 and 2002. This study followed up on an earlier study examining the prevalence of helmet use, in which only 12% of skiers and snowboarders surveyed were observed to be wearing helmets [365].

Consistent with principles of the DIT, it was first hypothesised that there would be an increase in wearing rates among skiers and snowboarders compared to the previous study conducted by Buller et al., [365], in that - adoption rates follow an escalating curve especially when they are first introduced into the "public market". Moreover, the DIT predicts that when the use of a new product such as helmets reaches 15% or more, the rate of adoption will escalate within that group, suggesting a social normative influence on use. The second hypothesis explored whether helmet use was greater among particular demographic groups (e.g., education level, frequent skiers/snowboarders, experts and intermediates), and lastly, if participants residing in the Rocky Mountain region and Canada, who are experts, who ski or snowboard often, and who are snowboarders showed an increase in helmet use from 2001 to 2002 than other groups (i.e., participants outside the regions, non-experts, occasional skiers/snowboarders).

Helmet use by skiers and snowboarders had increased and was most prevalent among snowboarders, experts and more frequent skiers/snowboarders [173]. Although the more experienced skiers were the ones more likely to wear helmets, adoption rates were becoming wide spread among beginners. Although the critical mass hypothesis (as stated in the DIT) was not supported, the authors mentioned that media coverage and marketing campaigns on helmets may have contributed to the upward trend in helmet usage amongst all skiers. It was also suggested that longitudinal follow up may be required to test the critical mass hypothesis further. Additionally, Anderson et al's., reasoning for why snowboarders increased use of helmets was suggested to be linked to snowboarders being part of a culture that utilises helmets in other recreational sports such as skateboarding, in-line skating and bicycle riding, whereas skiers may have been less likely to participate in these sports [173].

Anderson et al., suggested that skiers and snowboarders with higher ability and experience may wear helmets as they take more risk (ski or ride faster or on more challenging terrain), which is consistent with the risk compensation hypothesis [366]. However, it also may be that with knowledge and experience, skiers and snowboarders have a greater awareness of the risks involved and therefore adopt the appropriate protective devices to reduce such risks. Exploration of other factors (e.g., beliefs about benefits of helmet wearing among skiers and snowboarders, beliefs about susceptibility to injury) associated with risk is required, including investigations into the risk compensation hypothesis.

The application of DIT in these studies [173,239] has illustrated efforts to evaluate the process of diffusion, providing insights into some of the challenges involved in planning for program dissemination, and conducting rigourous research in the field. Clearly, it would appear immature to judge whether “network-based” interventions such as the DIT provide a significant benefit to sport injury prevention research and practice application. The initial evidence is promising, and continued application of the DIT is warranted to expand the approaches outlined by the studies illustrated [173,239] and to document effectiveness of sport injury prevention measures.

Future studies should evaluate the added benefit of network information for determining who should deliver messages and in what interpersonal and group settings. Future studies should also measure interpersonal communication about prevention messages to determine how individuals receive these messages and how their networks moderate or mediate program effectiveness. The realisation of who delivers "the message", and what the interpersonal context is, may be just as if not more important than the message itself, and may result in better, more relevant, and perhaps more effective programs. Studies should also ensure they are specific about what components of the model they are utilising, so this is clear to readers and provides insight into the conduct of future research that is replicable or can provide extension to such.

3.4 Planning Models

3.4.1 PRECEDE-PROCEED model

The PRECEDE-PROCEED model (Figure 3.5) is conceptualised as a mapping or logic model as it embraces causal assessment and intervention planning and evaluation into one overarching framework [367-370]. Its main purpose is to provide a structure for applying theories and concepts using a systematic approach for planning and evaluating health behaviour change programs [368,369].

A fundamental principle of the PRECEDE-PROCEED model is "participation", which refers to enhancing active participation of the intended audience in defining their own high-priority problems and goals and in developing and implementing solutions [250,369,371-373]. The fundamental approach of the model states that attempts should be made at each step in the assessment and planning stages for program planners to include input from the intended audience and relevant stakeholders. It is also acknowledged that programs should be supported with evidence-based information, model past successes, and include planned evaluation steps [368-370].

The PRECEDE component of the framework was developed firstly in the 1970's by Green, Kreuter, Deeds and Partridge [374]. The acronym stands for Predisposing, Reinforcing, and Enabling Constructs in Educational/ Environmental Diagnosis and Evaluation [374]. In an effort to address the concern of an overemphasis on implementing programs with little consideration for strategically designing interventions to meet requisite needs, PRECEDE is based on the principle that "educational diagnosis should precede an intervention plan".

In 1990, the PROCEED (Policy, Regulatory, and Organisational Constructs in Educational and Environmental Development) component was incorporated to the framework to recognise the importance of environmental factors as determinants of health and health behaviours [375,376]. In 2005, PRECEDE-PROCEED was further revised in response to the growing interest in ecological (i.e., multiple influences on behaviour, including factors at the intrapersonal, interpersonal, organisational, community, physical environmental and policy) and participatory (i.e., the success in achieving change being enhanced by active participation of the target audience in defining their own priority problems and goals and in developing and implementing solutions) approaches that were seen as essential elements for the success of public health programs in general [368,369].

Table 3.2

PRECEDE-PROCEED model as a framework for the application of BSSTM. Adapted from [377,378]

Change Theories and Principles by Level of Change	Phase 1: Social Assessment	Phase 2: Epidemiological, Behavioural, and Environmental Assessments	Phase 3: Educational and Ecological Assessment	Phase 4: Administrative and Policy Assessment and Intervention Alignment
Community level:				
Participation and Relevance	■	■	■	■
Community Organisation	■	■	■	■
Community Mobilisation	■	■	■	■
Organisational Change				■
Diffusion of Innovation				■
Interpersonal level:				
Social Cognitive Theory		■	■	
Adult learning			■	
Interpersonal communication			■	
Individual level:				
Health Belief Model		■	■	
Stage of Change		■	■	
Theory of Reasoned Action			■	
Theory of Planned Behaviour			■	
Information Processing			■	

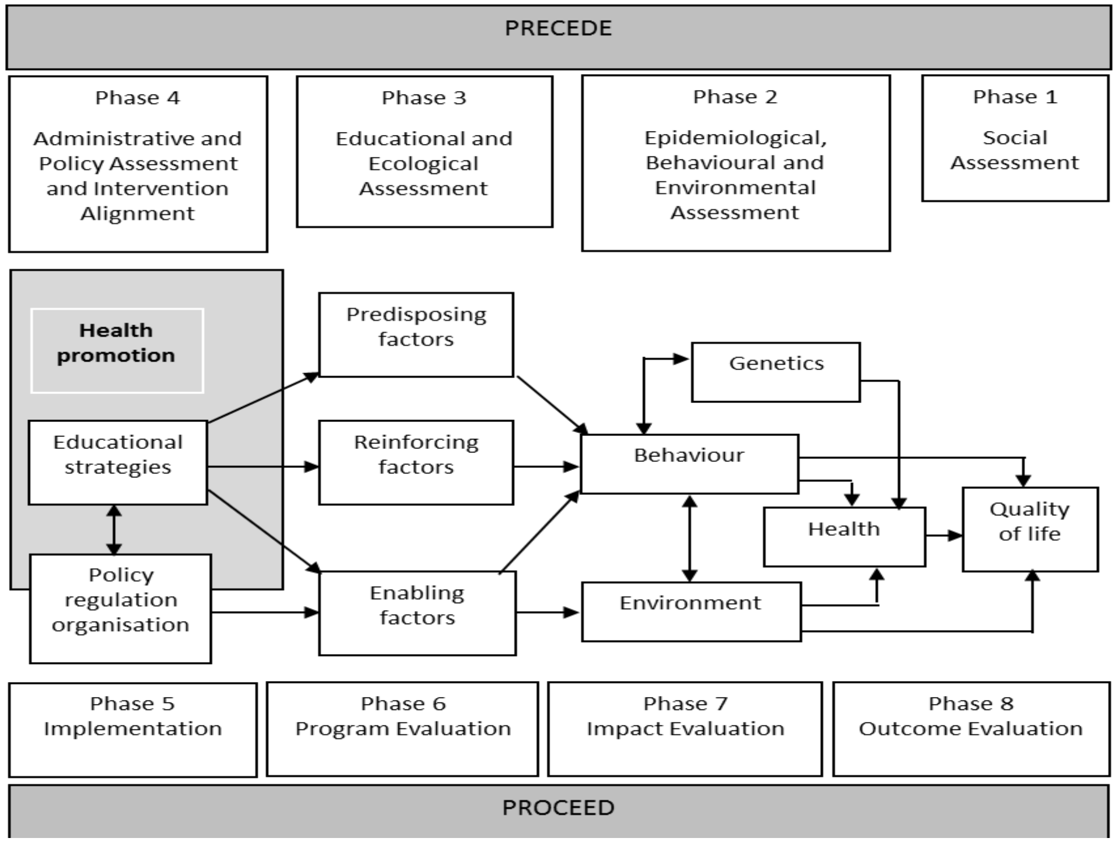

Figure 3.6. PRECEDE-PROCEED planning model. Adapted from [367,368]

Although the emphasis with the PRECEDE-PROCEED has been its utility for programs delivered in practice or real world settings, the framework has also been useful to researchers conducting health behaviour change intervention trials [369,370]. It has been widely applied to various injury topics including road safety, childhood injury, occupational safety, bicycle safety, military safety, and violence-related areas [142,170,311,314,379-396]. Perhaps surprisingly, to date, only one study has utilised this model in sport injury prevention [127,145]. This suggests that a significant proportion of programs in the sport injury context may be developed with relatively little consideration given to planning frameworks. This is an important gap because inadequate intervention development and planning may be one of the major reasons for ineffective interventions in the past.

While the PRECEDE-PROCEED model has been used in various ways in different settings and its many benefits highlighted, limitations of the studies applying the model exist. For example, studies do not always include the intended audience during the planning process, and authors rarely discuss if, or how, they have integrated social and behavioural theory with the model's constructs. It is often time consuming to use the PRECEDE-PROCEED and many studies do not specify intervention development and methods in detail. Nevertheless, this should not discourage researchers and practitioners utilising this model.

Simpson, Chalmers and Waller [145] described the design of a rugby union injury prevention program- "Tackling Rugby Injury" (TRI) using a population based approach. Using selected health promotion and injury prevention models and frameworks, including the PRECEDE-PROCEED, the Ottawa Charter and Haddon's Matrix, wider issues such as the social and physical environment, and national policy were incorporated into the conceptualisation (development/design) of TRI. At the outset, the design and/or the development of the program was also based on preliminary research findings of risk and protective factors identified in a New Zealand study (Rugby Union Injury and Performance Project, otherwise known as RIPP) [397]. Consistent with the PRECEDE principles, the design of the TRI program relied heavily on a collaborative, multi-disciplinary panel that included key members of the rugby union community which examined the findings from RIPP in light of practical experience, knowledge of the context and current practice in rugby union. Discussion among these key stakeholders revolved around identification of risk or protective factors and these included incidence of injury increasing with increasing grade of play; more than 1/3 of injuries in games being contact-occurring during a tackle or attempted tackle; head and face injuries occurring as a result of foul play; endurance training during off-season indicating a decrease in injury; prior injury increasing the risk of injury during the season; and alcohol-related behaviour being a major issue.

Application of the PRECEDE-PROCEED assisted to identify predisposing (beliefs, attitudes, values and perceived needs that support action in the future), enabling (conditions of the environment, actions by others or access to resources that make action possible) and reinforcing (ongoing rewards for a particular behaviour) factors for playing after injury.

The Ottawa Charter (Figure 3.7) [398,399] was used to identify strategies to reduce foul play in rugby union competitions and encouraged alternative strategies addressing expectations of fair play, personal skills and quality of refereeing, official support for referees' decisions, and the recruitment and retention of referees.

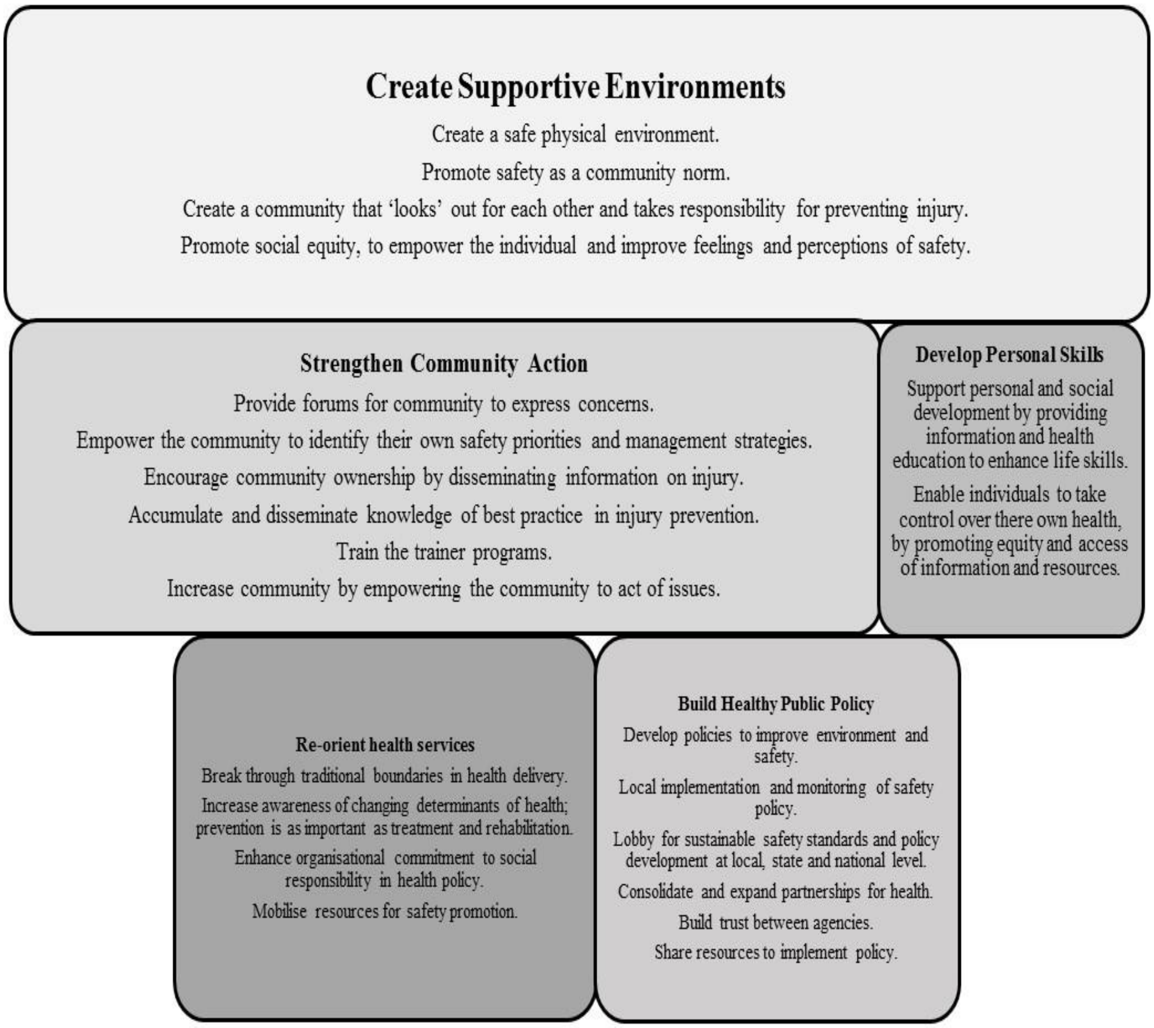

Figure 3.7. Ottawa charter for safety promotion. Adapted from [398,398,399]

Simpson et al,. [145] indicated recommendations and associated strategies for TRI were developed in five areas proposed by the key stakeholders likely to result in injury among players. Two additional areas focused on processes for implementing and evaluating the program. The authors advocated for a multi-dimensional approach to developing an injury prevention program and acknowledged the complexity of reducing injury within a sporting context.

The PRECEDE-PROCEED may provide a model for future program development in sport injury, however further research is needed. It is important that researchers planning to use this model ensure they not only utilise key stakeholders in the decision making throughout planning sport injury programs or interventions, but they also should ensure they are explicit about if and how behavioural and social science theory has been incorporated into model constructs. This is often a common limitation of many studies using the PRECEDE-PROCEED and a limitation of Simpson's study [145], in that, important determinants of behaviour may have been overlooked and therefore may have reduced the impact (i.e., adoption and maintenance of strategies to reduce injury) that the research translated into the real world may have achieved. It is also acknowledged [367,368] that other major limitations of the PRECEDE-PROCEED are that it can be time consuming to use and provides little guidance on intervention development and methods in details.

Future researchers should be encouraged to use the growing body of evidence-based literature that may specify community priorities, determinants or targets for change if time is an issue [368]. There are examples of studies where this has been done effectively in health promotion [368]. Intervention mapping [400] could also be used in addition to PRECEDE-PROCEED to overcome inherent flaws in the development and methods [368,401]. However, only a more recent study that used a component of intervention mapping to develop a neck injury prevention program has been applied [402]. Future efforts could explore such avenues.

3.4.2 Ecological model

The ecological approach provides a framework for explaining safety behaviour [403] and can comprehensively address public health problems such as sport injury [116,143]. The ecological perspective has grown out of a rich history and conceptual background that underlies contemporary thinking about "multilevel determinants of behaviour", and is grounded in both psychology and the science of public health [119,378]. For example, Albert Bandura's (1977) notion of reciprocal determinism and person-environment interactions in the social cognitive theory (see section 3.2.4) constitute psychology's recognition of the multiple influences of environment on behaviour.

There has been increasing interest in the use of ecological models in population health and safety promotion, [121] and a number of published studies have demonstrated the growing importance of this approach in a range of areas of health promotion (e.g. studies designed to promote physical activity) [404,405]. To date, the application of the ecological model in injury prevention and control has shown the most promise in falls injury prevention, road traffic injury prevention, and community safety promotion, [121] whilst research in the sport injury domain is only just beginning to emerge [143]. Unique to ecological models is the incorporation of multiple levels of influence on behaviour. Interventions that simultaneously influence multiple levels and multiple settings of an ecological system may be expected to lead to greater and longer-lasting injury outcomes [267,403,406]. The model aims to provide an integrated account of the complex array of possible intrapersonal, interpersonal, cultural and physical environment determinants. These levels highlight the interaction and integration of biological, behavioural, environmental and social determinants, as well as the influence of organisations (e.g. workplace, schools and football clubs), other persons (e.g. family, friends peers, or coaches), and public policies all of which together help individuals make safe choices in their daily lives [267,403]. Because of the multilevel perspective, ecological approaches to behaviour are inherently complex, [267] rather than comprising a series of specified constructs or variables, other theories and models can be incorporated within an ecological perspective to adequately reflect intrapersonal and interpersonal influences on safety behaviour [143].

As an illustration, specific to injury prevention, Hanson et al. [407] proposed the "injury iceberg" (Figure 3.8) to assist understanding of the important characteristics of the ecological model. Three dimensions to this model can be identified as: (1) the individual and their behaviour; (2) the physical environment; and (3) the social environment. Each dimension can then be analysed at five levels: (1) intra-personal; (2) inter-personal; (3) organisational; (4) community; and (5) societal.

Hanson and colleagues [407] asserted that the individual and their behaviour is, metaphorically speaking, at the "tip of the iceberg" as they are the most visible component of a complex ecological system constituting many levels, with important determinants of their behaviour and environmental risk "hidden below the waterline". Attempts to modify the risk of injury at one level in isolation (e.g. individual safety behaviour) may be resisted by the rest of the system, which will attempt to maintain its own internal stability (homeostasis). Thus, for example, if successful behaviour modification programs are to be developed to prevent sport injury, more attention will be needed to be given to the environmental context, as well as to the behaviour and risk profiles of individuals.

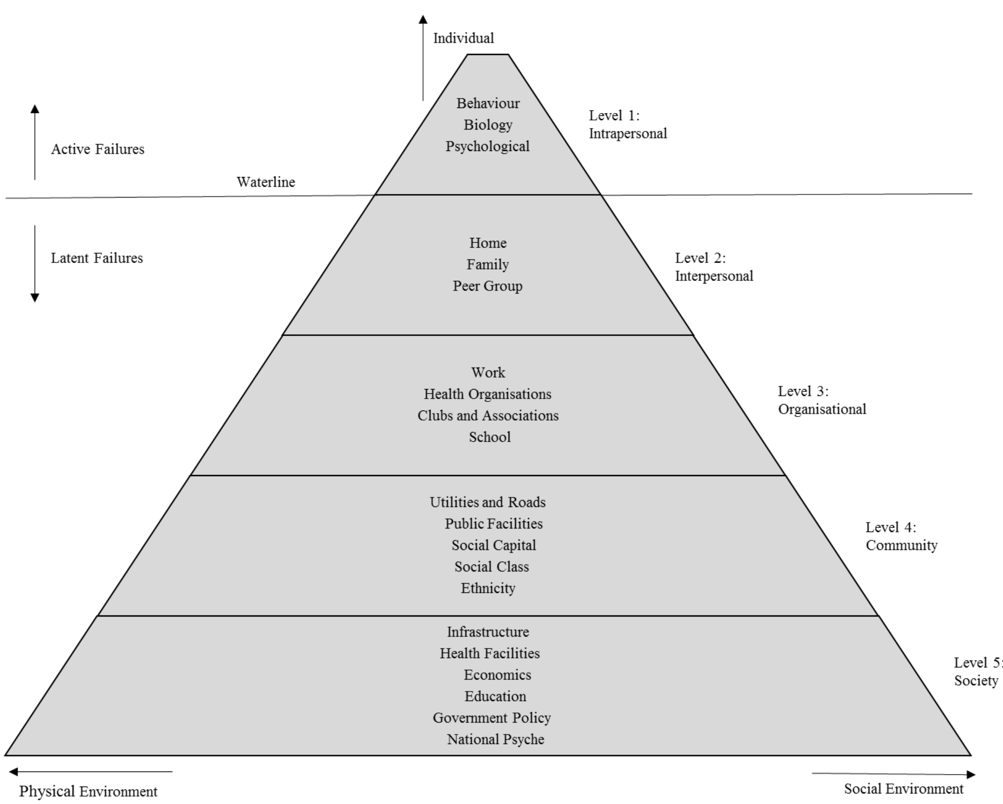

Figure 3.8. Illustration of the injury iceberg. Adapted from [407]

Each level is built on the foundation of a deeper level, as these levels become larger and exert more inertia, it becomes more difficult to change them. But once changed, these levels are more likely to sustain the desired outcome [407]. This injury iceberg model [407] allows for a complex web of causation and creates a rich context for multiple avenues of intervention. It can be used to “map the key links in an accident sequence or injury, identify upstream latent failures, along with the more obvious downstream active failures and can identifying some of the most strategic links thus ensures enhance effective action” [407] (p.2).

Eime, Finch, Owen, Gifford and Vear [143] outlined the behavioural principles guiding the design of a squash eyewear promotion initiative, the Protective Eyewear Promotion (PEP). Ecological principles of behaviour change were used to provide a comprehensive perspective on intrapersonal factors, policies and physical environmental influences of protective eyewear use (9). Factors at the individual player, venue and organisational level were taken into account.

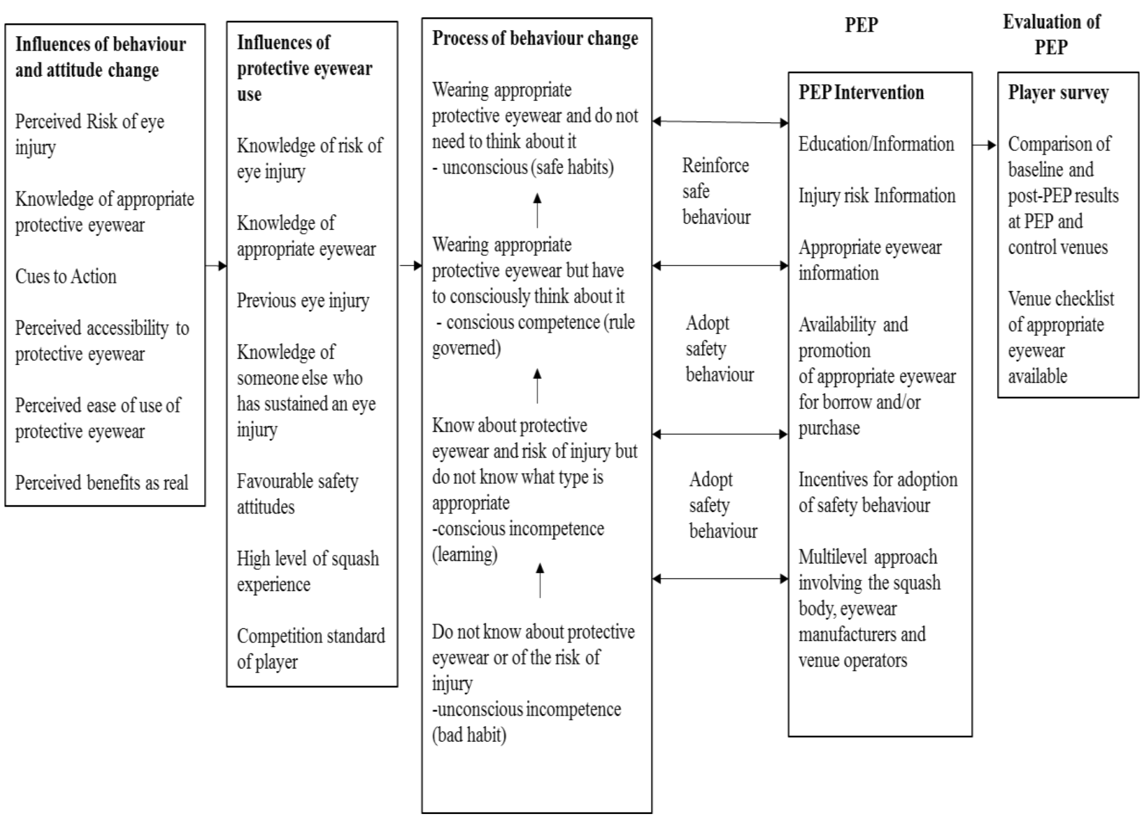

Figure 3.9. The conceptual framework of the protective eyewear promotion. Adapted from [143]

Results of baseline player surveys and venue manager interviews were used to assist in the development of the PEP strategy. The authors detailed some of the specific findings related to baseline venue manager interviews and player surveys (methods and full results were published elsewhere) [164]. To assist with understanding of the development of PEP, baseline results are summarised below.

In 2001 and 2002 squash venue managers were randomly selected for interview, in addition to a self- report questionnaire being completed by squash players (555 and 608, respectively) present at selected squash venues in metropolitan Melbourne [143]. The content of the squash venue manager interviews included: (1) overall injury risk perceptions; (2) eye injury occurrence; (3) knowledge, behaviours, attitudes and beliefs associated with protective eyewear; (4) compulsory protective eyewear; and (5) availability of protective eyewear at venues. The questionnaire provided to players consisted of: items related to player demographics; squash history (e.g., no. of hours played per week, total years of squash played, and participation level); previous injury and causation; use of PPE-eyewear; related knowledge and attitudes.

Based on the results for venue manager interviews, Eime et al., [143] found that the availability of eyewear at these venues for players to borrow/hire and/or purchase was lacking. This deficiency was influenced somewhat by venue managers' knowledge or uncertainty about the type of suitable eyewear to have available and where they could obtain it. Most venue operators did not play an active role in promoting the use of PPE-eyewear. The venue managers were however favourable towards obtaining education about eye injuries and PPE and taking a more active role in promoting safety behaviour. Venue managers also expressed concern about their ability to enforce a protective eyewear regulation and many anticipated negative reactions from players.

Of the 1163 surveyed squash players, 17% reported that they wore PPE-eyewear whilst playing squash, however, only 8% of players indicated that they wore the correct/most appropriate PPE-eyewear - polycarbonate lenses, and 74% of players indicated they had never attempted to wear polycarbonate lenses [143]. The most common reasons for use of PPE-eyewear included: players' knowledge of the risk of eye injury (53%); previous eye injury experience (28%); and knowing someone who has had an eye injury (37%). The reasons for non-use included: PPE-eyewear being uncomfortable/restricting vision (51%); they did not want to (31%); they never thought about it (26%); or the belief that PPE-eyewear was not necessary (22%). A small proportion of players (3%) indicated that they had sustained an eye injury within the past 12 months from squash. Although these results about player factors appeared to be linked with the HBM and components of the TTM, and a table was provided specifying concepts, the theories were not explicitly stated in the study.

Understanding the policies and physical environmental influences of PPE-eyewear use, as well as players' knowledge, behaviour and attitudes associated with PPE-eyewear, led to the development of PEP [143]. Behaviour change principles were applied to develop a comprehensive strategy to increase the use of appropriate PPE-eyewear. The main components of the PEP involved informing and educating players and venue managers of the risk of eye injury and of appropriate PPE-eyewear, through the use of task-specific posters, pamphlets and stickers displayed prominently at project venues. More explicit details of the behaviour strategies for change however would have been useful in this conceptual paper [143].

The PEP was implemented and evaluated over 4 months. A player questionnaire was administered following the intervention phase; results for this were however not reported by the authors in this paper [143] and reported elsewhere [160]. The promotional material continued to be displayed at the promotional venues following the intervention period in an attempt to influence future dissemination, widespread use, and sustainability of PPE-eyewear.

The authors [143] stated that the strong collaborative nature of this project involving the Victorian Squash Federation as the relevant sporting body, the venue manager and players, as well as the PPE manufacturers in this project provides a model approach to sports injury prevention research. "Collaboration", is indeed, an important component of successful interventions, [408] the authors

[143] however did describe the implementation of the PEP or how they were going to evaluate the PEP in this development paper [143]. These factors are certainly important to consider and plan for in the development phase. It may have been the case that implementation and evaluation were planned for, as suggested in a related paper [160]. However, it may be important for researchers in the area to consider adding such details in future development or conceptual-based papers, as these factors are crucial in the development phase of such interventions.

3.5 Summary and Conclusion

This review provides an in-depth description and critique of each of the studies that have been explicitly applied BSSTM in sport injury prevention research, as identified in the published systematic review [127] given in Chapter 2. This chapter has also considered some further perspectives on each of the BSSTM that have been presented in Chapter 2, and some thoughts on new theoretical directions.

Appendix E provides a summary table detailing the application, testing and development of BSSTM in sport injury prevention studies described in this chapter, and includes BSSTM studies that have been identified beyond the initial published systematic review (Chapter 2) from 2010-2014. These studies have highlighted that BSSTM, research, and practice are part of a continuum from understanding the determinants of behaviours, through to testing strategies for change, to disseminating successful interventions. Nonetheless, the use of BSSTM in the sport injury area has resulted in varying opinions and conclusions about their usefulness. At this point, no one single theory seems to address all the complexities that are components of preventive and other behaviours in sport. The field of behavioural science is complex and the limited use of BSSTM to date only goes partway towards a complete understanding of the conceptual basis of behaviour change to enhance the adoption and maintenance of preventive measures to prevent sport injuries.

Theories that focus on the preventive behaviour of individuals constitute an important part of the intellectual foundation of injury prevention research in sport. These theories have dominated the research literature in this area [127]. In particular, the TRA/TPB has been the most widely used theory in sport injury prevention research [127]. Only a very small number of studies have used BSSTM from a community/organisational level perspective and applied program planning models in their studies. Chapter 2 included a detailed discussion about how the BSSTM were used in published studies. It is important to recognise that broader, community- or organisational-level models and concepts are not intended to stand alone at the expense of neglecting the individuals that comprised those groups. Moreover, the predominant focus on individuals should not cause researchers to turn away from well-established theories and strategies. It is collectives of individuals who create structures, provide leadership in communities, and choose to participate- or not to participate- in coalitions, and make decisions about local, state and federal policies and priorities [267,403].

Each theory offers slightly different ways of predicting safety behaviour change. For example, while many theories emphasis individual cognitive processes, the HBM (and others like EPPM) focus somewhat more on perceived risk and fear of consequences. The TRA and SCT place more emphasis on social influences. However, rarely, have these theories been compared using the same datasets and across cultural settings to determine which might be more relevant or appropriate. Similarly, a test of each of the variables within each theory has yet to be simultaneously conducted to assess how variables differ in the contributions to behaviour regarding preventive-behaviours.

Although no theory is “perfect”, much has been learned in recent years about important elements of behaviour. Overall, BSSTM may vary in their applicability, depending on the situation and the persons involved. In some cases, elements of different theories themselves can be combined to get better results, for example, combining the self-efficacy construct with HBM, or the HBM and TPB. In doing so, researchers and practitioners are more likely to be able to develop interventions and strategies that will be maximally effective. Researchers should be encouraged not to make assumptions and presumptions regarding the expected behaviour, but rather should base the development of strategies and interventions on sound theoretical foundations.

Overall, BSSTM in sport injury prevention studies appears, in some instances, to have been used as a “loose framework” to which passing reference is made, rather than an integral part of a rigorous scientific process. Where a theoretical base for an intervention is stated, there has seldom been reference to a method describing how the BSSTM informed the design of the intervention, or how the evaluation tests BSSTM. This may reflect a lack of consideration (or understanding) as to how theory might be used to inform and evaluate the intervention at the planning stage, or poor articulation of these issues at the dissemination stage. Where theoretically informed interventions have been developed and thoroughly tested, there has been limited consideration of the implications of the findings for theory revision or development [127,377,378].

Frameworks, such as PRECEDE-PROCEED, have been developed for designing and evaluating complex interventions that give a theory a central role in the process. However, they do not give detailed guidance on how to use theory to design interventions, nor how to use evaluations of behaviour change interventions to develop and test theory. If researchers are to improve their understanding of how interventions affect change, to develop more effective interventions, and to use empirical evaluation to develop theory, there is need to develop a more precise and scientific method for linking behaviour change theory to designing and evaluating interventions to change behaviour. A common understanding of what “theory-based” is needed, as is a rigorous method for assessing the theoretical basis for intervention.

Over time, it is expected that the application of BSSTM to sport injury will evolve, as new studies arise and test formal predictions derived from BSSTM. This, in turn, is likely to enhance understanding of utilising BSSTM in sport injury contexts. To date, the extent to which dominant theories in psychology have evolved in sport injury prevention would appear to be slow and inefficient at best [127].

Comparing and contrasting theories is useful to "campaign designers" as it provides insight as to what input variables might be important to motivate target audience members towards specific outcomes [127,308,377,378,409]. More preventive interventions should reflect and measure multiple theoretical perspectives to both ensure completeness of data findings as well as rule out alternative explanations that might be described by one theory and not another [378].

As shown in Chapter 2, a number of studies have included constructs from theories that were not explicitly mentioned. One study that used the TRA/TPB also included the constructs of perceived susceptibility and perceived severity from the HBM [241]. The study conducted by Eime et al., [143] applied an ecological model but also used the HBM and the Transtheoretical (or stages of change) model (TTM) constructs. One other study used the PRECEDE-PROCEED in addition to the Ottawa Charter.

There is a significant dearth of information concerning the application, testing and development of BSSTM in sport injury prevention research. In some sense, BSSTM research in sport injury prevention is in its infancy and it is an area that has, to date, been largely atheoretical. Given this novelty, it is likely that there will be problems in pursuing a theoretical path, however with persistence the applicability, testing and development of theory is likely to contribute to the field moving forward. It is not likely that more effective programs will be designed until there is better understanding of why people adopt certain preventive measures and maintain use of these over the longer term.

Although sport injuries are due in part to other factors, behavioural and social factors play a part in reducing the risk associated with injuries sustained in sport. The pursuit of explanatory and intervention research seems to offer promising beginnings, as the remainder of this thesis will show.

Chapter 4: An Analysis of What we Currently Know About Coach-Injury Prevention Research in Sport

4.1 Introduction

Understanding sport injury-related determinants and how to initiate and sustain behaviour changes is pivotal to preventing injury in sport [31,127,265,266]. From the introduction of various injury prevention measures, such as PPE (e.g., headgear, mouthguards) and SET, to educational programs and rule enforcements, the evidence for the importance and efficacy of using prevention measures to reduce the risk of injury in sport has grown [32,117,118,146,410,411]. Yet, despite this knowledge, adoption, implementation and maintenance of injury prevention measures in differing sport contexts is not widespread [100,101,105,107-110,175], with the reasons for the lack of uptake or adherence being largely variable, and often unclear. Undoubtedly, the translation of sport injury prevention measures into actual sport practice environments is a multifaceted, complex process [31,127,266,412,413]. Strategies for reducing the risk of injury and enhancing uptake of injury prevention measures rely at least in part on behaviour to succeed and are only as effective as the sport organisations/clubs, coaches, sports/fitness trainers, consultants, and players that use or deliver them [31,127,266].

One key aspect (or change agent) that hinges on preventive behaviours and reducing subsequent injury risk among players and/or athletes in the context of sport is the role of the coach [127]. Coaches occupy a central and influential role within the athletic environment [413-419]. For example, coaches are expected to structure and lead practice sessions, give feedback and reinforce behaviours, communicate with all team personnel, designate the team's starting and non-starting players, and their influence can even extend beyond the sport domain into other areas of athletes' lives [412,420-422]. Coaches' roles are often characterised as a teacher, motivator, strategist, organiser, character builder and counsellor [415,423-426]. Indeed, virtually everything coaches do (whether “good or bad” or “positive or negative” on their athletes’ /players’ behaviours) can be viewed as attempts to increase certain desired behaviours and decrease undesirable behaviours [244,414,422,427].

It is recognised that coaches’ injury-related perceptions and behaviours should not be considered in isolation to others and wider factors in the athletic environment (including their own health/safety, work content and context) [31,127,266,419]. As leaders of the coaching process, they are in a position of leadership and by virtue of the “coach-athlete relationship” [428-431], coaches are well positioned to facilitate the initiation and maintenance of preventive measures to promote not only performance outcomes but also the health, well-being and safety of athletes. With National Sporting Organisations and newly established national accreditation schemes emerging over the last few years in some countries [432] coaches are asked to sign a ‘code of conduct’ which includes athlete health and safety. This further highlights the fact that injury prevention is a key responsibility of coaches. That said, if the information is not being translated to coaches this is problematic and they can only go with what they know, or seek out information through other means that may not be valid.

There is some evidence to suggest, however, that coaches may not be implementing injury-related prevention measures; for instance, specialised exercise programs to prevent LLI [124], or not reinforcing player behaviour to use protective equipment- mouthguards [202]. There have also been suggestions that certain coaching and/or training practices and processes (potentially unknowingly) may actually harm or increase the risk of injury for athletes [433-435]. While it seems understanding or modifying individuals’ injury related behaviours in the sporting contexts may be admittedly a formidable challenge, involving the coach as a key ‘change agent’ to assist in the process is optimistically achievable [127,436,437]. If injury preventive measures are to be communicated and uptake promoted in all coaching contexts (e.g., participation, performance), a deeper understanding of the nuances of various coaching contexts is necessary to foster the health and well-being of all sport participants. An understanding of the enablers and barriers to promoting a healthier and more enjoyable sporting context is central to the uptake of injury preventive measures.

To date, there has been a paucity of literature pertaining to coaches' determinants of injury prevention behaviours and only a small number of empirical studies have been conducted in this milieu [127]. Consequently, there is no comprehensive understanding of the role of coaches, their injury prevention behaviours, and the complex interplay of behavioural, psychosocial and other broader contextual and environmental factors that contribute to coach injury prevention practices in sport. In addition, with the exception of recent overviews of coaching science research (e.g., [421,427,430,436-441]) and other earlier general coach reviews [416,442-446] the field of coaching is bereft of such review appraisals. Chapter 2 investigated the extent to which BSSTM have been being used in sport injury prevention research. That systematic review introduced the rationale for investigating cognitive-behavioural approaches as integral in multi-faceted prevention efforts in sport. It found that only 11 out of 100 (11%) of the included studies applied used BSSTM, which was deemed to limit advancements in the sport injury prevention field. Though that review included studies specific to coaches, it did not consider the specific details of the literature investigating coaches and injury prevention, making it difficult to fully ascertain and guide how efforts focused on the role of the coach in sport injury prevention research endeavours and interventions could be supported. Thus, a broader review to identify what is known about coaches and injury prevention experiences in different sport settings and contexts is needed.

The literature regarding coach injury preventative behaviours clearly needs to be progressed to bridge the practice-research gap, and a systematic program of research to advance the evidence base regarding coach injury preventative behaviours is necessary. This chapter therefore aims to systematically review literature that has examined coaches and cognitive-behavioural aspects of injury prevention in sport. As this research is still in its relative infancy or an emerging field of research, it is important to carry out an exploratory scoping review [421,447] with a 'knowledge support' approach [448]. A 'knowledge support' scoping review including studies using a mixture of methodologies was carried out [421,447]. The objectives of the present review were to examine the extent, range and nature of the current state of coach injury prevention research and summarise the importance of these studies' findings in an effort to inform future research, practice (including coach injury prevention intervention endeavours), and policy; ultimately with the broader view of enhancing coach and athlete performance and ongoing healthy and safe participation in sport. Arskey and O'Malley's [447] scoping review framework was used as its iterative nature was appropriate to the review aims. In light of the background literature addressed in this introduction and the preliminary scoping exercise, the following review questions were posed:

(1) What research exists on coach cognition and behaviours specific to injury prevention during the last 25 years, including details of publication rates and what journals are used?

(2) What aspects of coach characteristics are measured and in what contexts?

(3) What is the topic focus of the studies - including coach injury prevention behaviours, the determinants and influences of coach injury prevention behaviours that have been examined, and the extent and nature of the use of theoretical models?

(4) What methodology approaches have been used in coach injury prevention research studies?

(5) What recommendations for future research, practice and policy specific to the role of the coach and sport injury prevention are made in existing studies?

4.2 Methods

This review aimed to investigate the complementary bigger picture of how the findings of the existing coach-injury prevention research as a whole can be combined to guide researchers and practitioners in the future [434,449,450] . An integrated design [451] of descriptive mapping and narrative synthesis was used to analyse the research [452,453]. This review included a mix of papers with a range of research questions, data collection methods and analysis (numerical and textual). The findings from this review are represented as a description of the content, a quality assessment of the studies, and a summary of the arising themes within this review.

4.2.1 Search and selection strategies

In the initial stage, the search and selection strategy involved identifying coach papers through the systematic review process shown in Chapter 2 investigating the extent to which behavioural and social science theories are used in sport injury prevention research. A further search, replicating the approach from Chapter 2 was conducted to identify any additional coach-related injury preventive studies that had been published since their review, with a specific filter (i.e., coaches, injury, injury prevention, and sport) applied to explicitly identify coach-related articles. The search was expanded, however, to include popular coach-related journals, including, the *International Journal of Sports Science and Coaching; Psychology of Sport and Exercise; Applied Research in Coaching and Athletics Annual; International Journal of Coaching Science;* and *Journal of Applied Sport Psychology*. Search keywords were combinations based on SIP measures (e.g., PPE, education, and exercises- warm-up, stretches), sport activities (team and individual sports – basketball, football, soccer, netball, athletics etc.,), cognitive-behavioural models (e.g., theory of planned behaviour, social cognitive theory), specific factors (e.g., self-efficacy, perceived barriers), injuries (e.g., anterior cruciate ligament, concussion) and research methods (e.g., qualitative, survey design). Limits were applied to searches including English language articles only, from the earliest records to June 2014. The search results were screened and assessed studies against the inclusion criteria (Table 4.1). The final number of studies included was from 27 articles, with seven studies [128,129,454-458]} published since Chapter 2. Figure 4.1 shows a summary of the systematic process of selecting studies identified for this review.

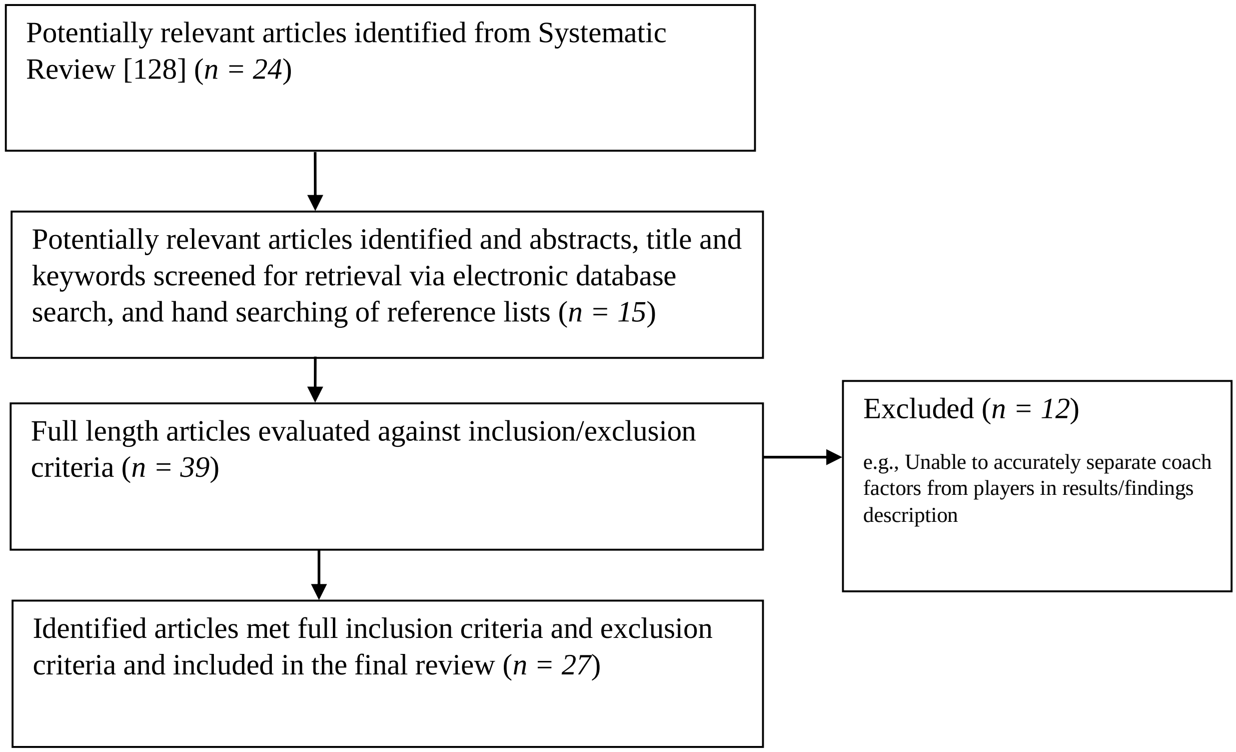

Figure 4.1. Summary of the systematic search process and the number of articles considered at each stage

Table 4.1

Inclusion and exclusion criteria for selecting papers to be included in the systematic review. Adapted and modified from McGlashan & Finch, 2010 [127]

Inclusion criteria	**Exclusion criteria**
• Full text (complete) peer-reviewed, English Language, earliest records-June 2011 • Original research studies • Studies relating to all ages and genders • Sports activities in both formal, competitive and social/recreational settings • Unintentional injuries • Target population- coaches • Studies specifically related to specified safety behaviours or behavioural interventions to prevent acute sport injury e.g., PPE, warm-up • Mention of behavioural and social sciences themes, aspects or approach • Primary and secondary prevention	• Studies relating to chronic, recurrent or overuse injuries or illness-related conditions • Studies not published in the peer-review literature, reports, reviews, theses and conference proceedings: not reported as full peer-review paper • Intervention studies not considering behavioural-related factors or measures requiring some element of behaviour change • Reviews or commentaries on injury prevention interventions, even if peer-reviewed • Studies relating to violence-related behaviours or intentional injuries

4.2.2 Review, classification and coding of selected studies

In stage two, an ethnographic content analysis (ECA) method was applied to determine relevant characteristics or concepts within the text of each study [459,460]. A review form based on previous studies [122,127,421] was developed to map, summarise and categorise characteristics of selected studies. The characteristics of the studies included: (1) year of publication, (2) journal title, (3) coach injury prevention research focus- explicit theory/model use (that is, whereby a theory/model was clearly stated as a key aspect of the design or conduct of the study [8]) and atheoretical studies (studies where there was no clear evidence for the use of a theory or model in the design or conduct of the study [8]), determinants and influences of use of preventive behaviour etc., (4) general methodology (quantitative, qualitative, mixed-methods), study design (e.g., cross-sectional, randomised control trial, case-control, cohort, qualitative-related) and data collection used (e.g., questionnaires/surveys, interviews, observation), (5) coach demographic and context features (e.g., country of origin, classification and type of sport, injury prevention behaviour/safety measure, injury type and level of coaching), and (6) limitations of studies.

In the third stage, a series of data matrices for each of the characteristics of selected studies was developed in order to synthesis, analyse and tabulate the data further. The text was systematically analysed by generating code categories directly from the data, and then continually reanalysed the codes, allowing other code categories to emerge. Once coded categories were assigned, count frequencies for each category were undertaken.

Studies [129,454,455] identified as having explicit- theory use were summarised according to Trifiletti and colleagues [122] classification (excluding those studies [111,138,239] previously identified and examined in Chapter 2. Explicit-theory based studies were also further analysed to identify factors considered in the study in relation to the specific theory and those identified as factors associated with coach injury prevention behaviours. Atheoretical studies were mapped to relevant theory constructs.

The general methodology reported in each reviewed study was coded as quantitative, qualitative and mixed-method to differentiate these types of research [461-464]. Quantitative research frequently emphasises quantification in the collection and analysis of data. As a research strategy it is deductivist and objectivist and incorporates a natural science model of the research process (in particular, one influence by positivism) [463]. Qualitative research typically emphasises words rather than quantification in the collection and analysis of data, it is inductivist, constructionist, and interpretivist [459,463]. Mixed methods research combines the use of both quantitative and qualitative research [464,465]. To ascertain specific study designs studies were coded as cross-sectional, case-control, cohort, randomised controlled trial, qualitative-related/other [463,466]. The matrix for methods of data collection was developed on the basis of common methods including questionnaires, interviews, focus groups, observation and other.

4.3 Results

A detailed description of the coach injury prevention studies included in this review is provided in Appendix F. The following provides a further synthesis of the relevant information pertaining to each of the studies including: (1) an overview of published studies by year and journal, (2) coach demographics and context (geographical location of study, type of sport, and level of coach, coach injury prevention behaviour), (3) the focus of the study (including theory use or not, role of theory, and factors or determinants/influences of coach injury prevention behaviour), and (4) general methodology, study design, and data collection.

4.3.1 Overview of published studies by year and journal

The earliest study identified was published in 1991. From 1991 to 2014, 27 peer-reviewed articles have been published in coach injury prevention research. The years were delineated into 5-year periods for comparison of equal period of time (see Table 4.2). On average, fewer than one article was published each year over the first 15 years. There has however been a steady increase in articles published over the last decade, with annual publication rates increasing by an additional 2.0% (10 articles) in the periods from 2006-2010, compared to previous 2001-2005 figures. However, the last 4 years (2011-2014) had shown a decrease in publication rates. Overall, more than half of these studies have been published in the last 7-8 years, so it seems the coach-injury area is becoming of increasing interest, despite more recent drops (i.e., last 4 years) in the number of articles being published.

Table 4.2

Published research articles by year (1991-2014)

Year Period	**Articles (n)**	**Articles (%)**	**Yearly mean (n)**
1991-1995	2	7.41	0.4
1996-2000	3	11.11	0.6
2001-2005	4	14.81	0.8
2006-2010	14	51.86	2.8
2011-2014	4	14.81	1.0
Total	**27**	**100.0**	

Note: 4 studies were published from 2011 to 2014 (4 year aggregate), therefore yearly mean (n= 1.0) is based on 4 years only *(n articles/1 year = n yearly mean*) and not aggregated over 5 years (*e.g., n articles/5 years = n yearly mean*) as computed in other categories.

Table 4.3 shows a listing of the journals (and number of articles per journal) utilised to publish coach injury prevention research articles. Seventeen different journals were used to publish and disseminate research evidence. British Journal of Sports Medicine published the most cited articles, followed by Dental Traumatology. Most journals were relevant to disciplines of sports science, in general (e.g., Journal of Science and Medicine in Sport). Three journals were specific to dentistry and others were more associated with injury prevention, health promotion, and public health. A few were related to athletic training or strength and conditioning research. Only one journal focused specifically on coaching - International Journal of Sports Science and Coaching.

Table 4.3

List of journals used to publish coach injury prevention articles (n = 27 articles)

Journal	Articles	
	n	**%**
British Journal of Sports Medicine	5	18.5
Dental Traumatology	4	14.8
Journal of Science and Medicine in Sport	3	11.1
Clinical Journal of Sports Medicine	2	7.4
International Journal of Sports Science and Coaching	2	7.4
Health Promotion Practice	1	3.7
Injury Prevention	1	3.7
Journal of the Indian Society of Pedodontics and Preventive Dentistry	1	3.7
Journal of the Louisiana State Medical Society	1	3.7
Journal of Athletic Training	1	3.7
Journal of Strength and Conditioning Research	1	3.7
Journal Public Health Dentistry	1	3.7
Scandinavian Journal of Medicine Science and Sports	1	3.7
Sport Health: A Multidisciplinary Perspective	1	3.7
The American Journal of Sports Medicine	1	3.7
The Journal of the American Dental Association	1	3.7

4.3.2 Coach demographics and contextual features

4.3.2.1 Country of origin

Figure 4.2 shows a comparison of the number of coach injury prevention studies per country of origin. The United States has dominated in publishing the most studies ($n = 13$), followed by Australia ($n = 4$) and Canada ($n = 3$).

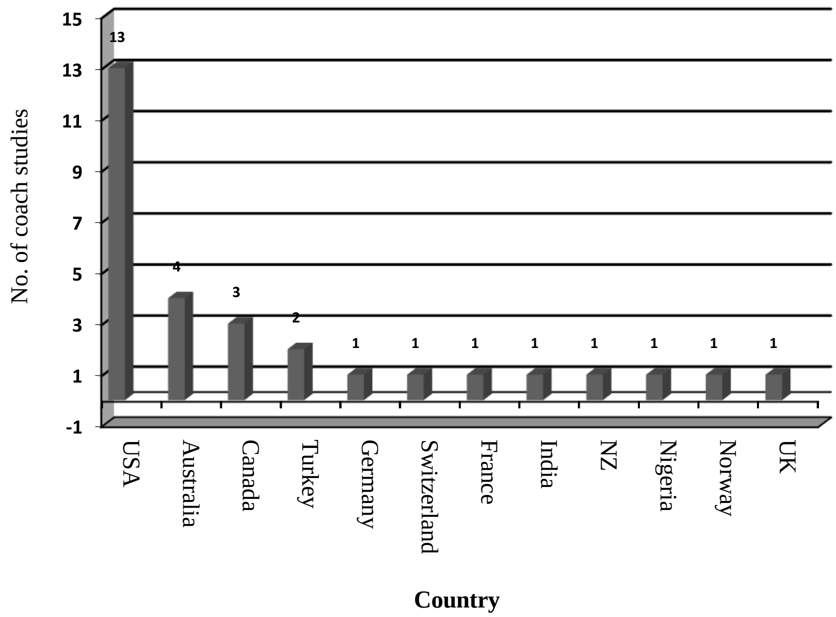

Figure 4.2. Comparison summary of number of studies conducted in each country (n = 27 studies)

Note: 2 studies [214,215,455] are cross-cultural, therefore total number of studies does not add to 27 studies (e.g., Germany, Switzerland and France compared in same study); USA= United States of America; NZ= New Zealand; UK=United Kingdom.

4.3.2.2 Classification and type of sport

A total of 10 different sports (excluding a "various sports" category) were represented in the reviewed coach injury prevention studies, refer to Table 4.4. Team-based sports (*n = 9*) outnumbered individual based sports (*n = 1*) considerably. About half (*n = 14*) of all studies were related to team ball sports and nine studies were associated with the football codes (Soccer, Rugby Union, AF and American football). Nine studies covered various sports.

Table 4.4

Classification and type of sport (n = 27 studies)

Classification of Sport [a]	**Type of Sport**	**n**	**%**	**Team or individual sport**	**Reference**
Ball Sports	Soccer [b]	4	14.8	Team	[114,238,456,458]
	Netball [b]	3	11.1	Team	[128,129,238]
	American Football	2	7.4	Team	[202,227]
	Rugby Union	2	7.4	Team	[175,225]
	Basketball	2	7.4	Team	[111,457]
	Australian Football	1	3.7	Team	[124]
Bat & Ball Sports	Baseball	1	3.7	Team	[167]
	Cricket	1	3.7	Team	[230]
Winter Sport	Ice Hockey	2	8.7	Team	[455,467]
Racquet Sport	Squash	1	4.3	Individual	[215]
Other	Various Sports[c]	9	39.1	Team and Individual	[138,158,198,199,212,213,229,239,454]

Note: a- classification of sports based on ICD-10-AM activity code (U50-U73) classification [468]; b- sample of netball and soccer players were included in one study; c- studies including various team and individual sports (mostly in US at high school/college levels) e.g., track n field, wrestling, soccer, baseball, softball, volleyball, cheerleading, football, and basketball.

Note: % scores calculated on the basis of 27 studies, therefore total does not equal 100% due to multi-sports included in one study [b].

4.3.3 Injury prevention behaviour/safety measure and injury type

Table 4.5 shows studies targeting personal protective equipment (PPE) have predominated in studying coach injury prevention behaviours (n=10 studies), with most studies focusing on mouthguards (n=6). To a slightly lesser extent, a further six coach studies have been conducted in relation to coach education and four studies have focused on SET. Associated injury types related to a range of injuries from oral-facial to LLI.

Table 4.5

Summary of coach injury prevention behaviours and injury type

IP Behaviour/Safety Measure	Injury Type or Body Location	No. of studies	% of studies	Reference
PPE		**10**	**43.4**	
Mouthguard	Oral-facial	6		[198,199,202,212-215]
General	Lower Limb	2		[138,158]
Faceguard	Oral-facial	1		[167]
Headgear	Head	1		[175]
General IP		**1**	**4.35**	
SET		**4**	**17.3**	
Pre-exercise stretching	All	1		[229]
Biomechanical and neuromuscular exercise training (intervention)	Lower limb	1		[114]
Biomechanical and neuromuscular exercise training (non-intervention)	Lower limb	1		[124]
Correct Landing Technique	Lower limb	1		[128]
Fast bowling training and practices	Back	1		[230]
Multi-intervention	Lower Limb/Knee (ACL)	**2**	**8.6**	[111]
Educational Intervention		**6**	**26.0**	
Safe tackling video	Neck/Cervical	1		[227]
E-learning	All	2		[454,455]
Face to face workshops/resources	All	1		[129]
Toolkit	Concussion	1		[239]
Concussion safety literature, web-based information, seminars	Concussion	1		[467]

Note: ACL = anterior cruciate ligament

4.3.3.1 Level of coaching

Table 4.6 shows a summary of coaching level in each of the studies in this review. Most studies investigated junior/youth and high school coaches (n=19), followed by College/University levels (n=6). Five studies used multi-level coach samples in their studies.

Table 4.6

Summary of coaching levels in reviewed studies (n = 27 studies)

Level of Coaching	n	Reference
Junior/Youth/High School	16	[111,128,129,138,158,167,175,198,199,212,215,227,229,239,454,455]
College/University	6	[114,158,175,202,212,213]
Amateur/Semi-Professional	1	[214,215]
Elite/Professional	2	[124,230]
National level	1	[175]
All levels (non-specific)	1	[238]

Note: total n does not add to 27 studies as some studies used coaches from study participants at multi-levels

4.3.4 The topic focus of coach injury prevention research

Most studies in this coach injury prevention review were atheoretical (n = 21, 75%) and only six studies (25%) explicitly stated the use of theory. Table 4.7 shows a comparison of the total number of explicit theory- versus atheoretical- coach injury prevention studies published since 1991. While there has been a steady increased trend in atheoretical studies published over the last 20 years, explicit theory studies only emerged in 2005 with a study conducted by Yang et al., [138] investigating the prevalence and determinants of the use of discretionary PPE in high school athletes in the United States. Between the periods 2006-2010, an increased number of explicit theory studies (n=4) were published [111,129,239,454]; however this is still approximately 50% less than the number of atheoretical studies published [108,124,212,213,215,225,229,238,455,456] during this period. Since 2011 only three studies have been published, two were atheoretical [457,458] and only one study [128] used theory - focusing on junior netball coaches and correct landing technique as the preventive measure.

Table 4.7

Total number of explicit theory- versus atheoretical- coach injury prevention studies published (per year periods since 1991 to 2014) (n = 27 studies)

Year Period	**Explicit Theory**		**Atheoretical**	
	n	References	n	References
1991-1995	-	-	2	[202,230]
1996-2000	-	-	3	[167,198,227]
2001-2005	1	[138]	3	[158,175,199]
2006-2010	4	[111,129,239,454]	10	[108,124,212,213,215,225,229,238,455,456]
2011-2014	1	[128]	3	[457,458,467]
Total	**6**		**21**	

Table 4.8 provides a summary and brief description of the theories and models used in coach sport injury prevention studies. A fuller overview of the focus of coach injury prevention research studies applying an explicit-theory and atheoretical approaches is presented in Table 4.8 and Table 4.9, respectively. The studies including explicit- theories use included individual (intra- and inter-personal) level theories such as the HBM [454], TRA/TPB [111,128,454], and the SCT [138,454]. Community level theories utilised in studies were the DIT [239] and the RE-AIM framework [129]. Two studies used a combination of two or more theories [111,111,454]. Of the explicit-theory studies, a number of theoretical constructs or factors associated with reported coaches' injury prevention behaviours were knowledge, self-efficacy, behavioural intention, perceived benefits, social environment and other socio-cultural factors (Table 4.9).

Table 4.8

Summary of key theories and models used in coach injury prevention studies

Theory/ Model	Reference	Level	Brief Description of Theory/Model	Concepts/Constructs/ Factors
HBM	Janz [242,277]	Intrapersonal	Health or preventive behaviours are a function of an individual's belief about their or others susceptibility to a health/injury problem, the severity of the health/injury problem, the benefits versus the costs of adopting the preventive behaviour and experiencing a cues to action to perform the behaviour. The concept of self-efficacy, which is an individual's confidence to perform a specific behaviour, is also taken into consideration.	Perceived severity Perceived susceptibility Perceived benefits Perceived barriers Cues to action Self-efficacy
TRA/ TPB	Ajzen [297,469,470]	Intrapersonal	Individuals express an intention to perform a behaviour (behavioural intention). This entails developing a positive attitude towards the behaviour (attitude towards a behaviour), perceiving approval or encouragement to perform the behaviour (subjective norms), and believing in their ability to perform the behaviour (perceived behavioural control).	Behavioural Intention Attitude toward a behaviour Subjective norms Perceived behavioural control
SCT	Bandura [244,328,471]	Intrapersonal Interpersonal	Three factors contribute to behaviour change: self-efficacy, goals and outcome expectations. Individuals must believe that their actions will result in improvement. They must have the skills and the belief that they will perform the action successfully. Social and physical environments may be barriers or facilitators to change.	Reciprocal determinism Behavioural capability Expectations Self-efficacy Modelling Observational learning Reinforcement
DIT	Rogers [357,359,362]	Interpersonal Community/ Organisational	Diffusion of innovations (concepts, behaviours, technologies) occurs in stages (stages of diffusion). Some individuals adopt innovations earlier than others (adopter categories). Attributes of the innovation may influence the rate of adoption.	Stages of diffusion Knowledge Persuasion Decision Implementation Confirmation

Theory/ Model	Reference	Level	Brief Description of Theory/Model	Concepts/Constructs/ Factors
				Adopter categories Innovators Early adopters Early majority Late majority Laggards
RE-AIM	Glasgow et al., [472]	Ecological -Interpersonal -Intrapersonal -Community/ Organisational	The RE-AIM framework proposes five dimensions necessary to examine the impact of a given intervention: (a) reach- the proportion of the target population that participated in the intervention; (b) efficacy/effectiveness- the success in promoting health/preventive behaviour; (c) adoption – the proportion of settings that subsequently uses the intervention; (d) implementation – practitioners fidelity to the interventions protocol; (e) maintenance – the level of sustained use of the intervention over time. The RE-AIM acknowledges individual and organisational levels of impact. Reach and efficacy/effectiveness are measured at the level of the individual. Reach reflects the number of individuals, whereas efficacy reflects the degree to which people's behaviour changes at an individual level. Adoption and Implementation are organisational or contextual levels; adoption is the number of organisations or individuals that begin the intervention, and implementation is how well the protocol of the intervention is adhered to at an organisational or contextual level. Maintenance reflects both an individual and organisational level in that the sustained behaviour of individuals and organisational use of an intervention can be documented.	Reach Effectiveness Adoption Implementation Maintenance

Note: TRA/TPB= Theory of Reasoned Action/Theory of Planned Behaviour; HBM= Health Belief Model; SCT= Social Cognitive Theory; DIT= Diffusion of Innovation Theory; RE-AIM= Reach, Effectiveness, Adoption, Implementation, Maintenance

Table 4.9

Overview of coach-related injury prevention studies using theory

Reference	Theory	Injury behaviour and injury focus	Coach factors considered	Identified coach factors related to injury prevention behaviour	Use of theory Based on Trifilletti et al., Classification [122]
Individual level					
[111]	TRA, TPB	Multi-intervention – ACL- Knee	Knowledge Attitude Behaviour	Knowledge about ACL and injury risk factors for ACL increased significantly at post-implementation, no significant change in attitude toward injury risk or self-report injury practices. Coaches who scored higher on the ACL knowledge scale reported more favourable attitudes toward ACL injury prevention technique and practices. Their players also scored higher, than average, on the post-test assessment. Observed use of two footed landing by players improved during the study, however there was not a strong correlation of player and coaches' self-report use of preventive practices and observed use. Changes in knowledge, attitudes and practice varied by school. Changes in players' knowledge, attitudes and practices post- assessment reflected their coaches' knowledge, attitudes and practices at baseline.	Measured theory or construct
[128]	TPB	Correct Landing Technique – Lower limb	Attitude Subjective Norm Perceived Behavioural Control	Overall >94% of coaches had positive attitudes towards toward teaching correct landing technique. >80% had positive perceptions of their own control over delivery of such programs. Coaches' ratings of social norms relating what others think about teaching safe landing technique were more positive (>94%) than those relating to what others do (63-74%).	Guide program design and/or implementation, evaluation Measure theory or construct
[454]	HBM, TRA, SCT	Coach Education- Concussion	Knowledge Attitude Self-efficacy Behavioural intention	Knowledge (symptoms, general and misperceptions) Self-efficacy Behavioural Intention	Guided program design and/or implementation and evaluation Measure theory or construct
[138]	SCT	PPE- Lower limb	Social environment (player-coach ratio) Behavioural Capability (Coach experience, qualifications and training)	Social environment (low player/coach ratio)	Guided program design and/or implementation.

Reference	Theory	Injury behaviour and injury focus	Coach factors considered	Identified coach factors related to injury prevention behaviour	Use of theory Based on Trifilletti et al., Classification [122]
					Measured theory or construct
Community level					
[239]	DIT	Coach Education – Concussion	Diffusion stages- (1) Gaining knowledge about the innovation; (2) Forming positive attitudes relative to adopting it (3) Deciding to adopt it; (4) Using the innovation; (5) Confirming its usefulness Other – (a) Coach demographics (sports taught, yrs. of experience, gender, awareness of incidence of concussion at school, access to preventive materials) ; (b) School context variables (size of student body, geographical setting of school, socioeconomic status, plan of preventing and managing concussion)	Receipt of toolkit; assessment materials (looked at toolkit and recalled specific materials) Actual use or intentions to use Reasons for non-use Preferred method for accessing material in the future Material used to develop or improve existing plans for concussion Perceived benefits, overall appeal, ease of use, amount of content and usefulness, benefits expected from use of kit, satisfactions with it compared to other prevention materials and whether they would recommend to other school staff	Guided program design and/or implementation Measured theory or construct
[129]	RE-AIM	Multi-Intervention-Lower limb	Reach- the exposure of the programme to both coaches and junior players Effectiveness – coaches' perceptions about if the intervention D2E program worked in relation to outcome measures Adoption- coaches' responses to facilitating adoption of D2E (age group and skills level) Implementation- coaches' opinions on resources to improve implementation; factors or circumstances identified as challenges for implementing; no. of coaches providing feedback Maintenance-no. of coaches who intend to use D2E with players in the future	Reach enhanced from initial efficacy study Effectiveness – coaches believed that the Down to Earth (D2E) Program was effective in: (1) improving correct landing technique; (2) reducing LLI risk in their players; (3) improving performance measures Adoption – coaches more likely to consider D2E relevant for under 13 and under 15, and less skilled netball players Implementation- coaches indicated lack of: ideas for training drills, time, coaching skills, training space and training equipment; player factors- players not listening/lack of motivation, older players thinking they do not need it, players not attending training, training drills boring Maintenance- majority of coaches indicated they would continue program in the future	Guided program design and/or implementation Measured theory or construct

Note: TRA/TPB= Theory of Reasoned Action/Theory of Planned Behaviour; HBM= Health Belief Model; SCT= Social Cognitive Theory; DIT= Diffusion of Innovation Theory; RE-AIM= Reach, Effectiveness, Adoption, Implementation, Maintenance; ACL= anterior cruciate ligament (knee)

Table 4.10 shows the themes and subthemes that were identified and emerged in the text data through conducting an analysis of the atheoretical coach injury prevention studies. The themes that most commonly emerged in the literature were: (1) a coach's injury prevention intentions, goals and behaviours/practices, and (2) coaches' perceptions of threat/risk of injury and its consequences. Other themes included perceived benefits and perceived barriers of using injury preventive measures, coaches' confidence and control in implementing preventive measures and attitudes towards injury prevention behaviours/practices. A number of these themes were deemed consistent with existing behavioural theory/model constructs/factors.

A summary of factors identified in the atheoretical coach injury prevention studies related to injury prevention measure categories is shown in Table 4.11. Overall, the coach's perceived threat/risk of injury and its consequences was the most common theme across three injury prevention measures, PPE, general IP, and SET. Six main themes were related to PPE including behaviour, perceived threat/risk of injury and its consequences, perceived benefits of using preventive measure, perceived barriers of using preventive measure, coaches' confidence in their ability to implement a preventive measure and attitude towards the preventive measure use. Four themes were related to SET (behaviour, perceived threat/risk of injury and consequences, perceived benefits of using preventive measure, perceived barriers of using preventive measure) and only one main theme, perceived barriers of using preventive measures was related to coach education.

Table 4.10

Summary of identified themes and subthemes in atheoretical coach injury prevention studies

Themes/ Sub-themes	n studies	Example	References	Relevant theory/model and/or construct/factor
Injury prevention intentions, goals or behaviour/ practices	**10**	*"Across all sports, 28% of coaches reported that some athletes used mouthguards regularly. 31% of coaches reported that they would not encourage mouthguard use".* [198] *"Coaches did not routinely use plyometric training or agility drills on field, the weight room or during off-field practice sessions".* [114] *"The beliefs about training elements were consistent with the content of the observed coach-led training sessions, in that, the most time was spent on game-related skills training. Only one club had a structured warm-up. In contrast to coaches' importance rating for endurance training for team performance, five teams did not include this in observed training sessions. Sprinting was observed at seven clubs, despite coaches generally indicating that they were unconvinced of its important. Little or no time was spent on balance, jump/landing and sidestepping techniques".* [124]	[114,124,167,198,199,202,212,213,229,230]	HBM TRA/TPB SCT
Perceived threat/risk of injury and its consequences	**10**	*"In general, the findings suggested that coaches in this study had limited injury risk knowledge. While 71% of coaches identified the tackle as the game situation in which most injuries occur, only about half of coaches identified the upper limb of the tackler as the body part most likely to be injured in a tackle and one-quarter identified the lower limb of the ball carrier. Most coaches (97%) believed that previous injury increased the risk of re-injury".* [225]	[124,158,167,175,198,212-215,225,229]	HBM Perceived Susceptibility Perceived Severity
Perceived benefits of using preventive measure	**7**		[124,167,199,202,204,212,213,229]	HBM Perceived Benefits SCT Outcome Expectancies
Reduced the risk of injury	5	*"Headgear reduces the incidence or severity of concussion".* [175] *"Most of the coaches believed the mouthguard was effective in protecting against oral-facial injuries".* [199]	[124,199,212,213,229]	
Enhance adherence	2	*"coaches reported that mouthguard rules and enforcement of rules was beneficial in determining player compliance and resulted in more frequent use".* [202]	[167,202]	

Themes/ Sub-themes	n studies	Example	References	Relevant theory/model and/or construct/factor
Improved performance/fitness components	**2**	*"All coaches agreed they would implement specific training if it both improve performance and prevented LLI".* *"Improves conditioning, establishes a rhythm, and assists improve mental preparation".*	[124,229]	
Improved socialisation (or cohesion)	**1**	*Half of the coaches believed that it also provided a socialisation aspect.*	[229]	
Perceived barriers of using preventive measure	**5**			HBM -Perceived Barriers SCT -Behavioural capability
Cost	3	*"Coaches were worried that the cost of playing rugby would increase".* *"The choice of mouthguard by coaches for their athletes was the quality of the oral protection, followed by the cost".*	[175,198,199]	
Lack of time	2	*Coaches -(1) "did not have enough time to use the drills from the website, despite the perceived value", (2) "coaches did not want to waste time watching the media/animation and the site hadn't been taken to the next level for coaches (not user friendly access)", (3) some coaches lost interest and did not have time so did not complete" and (4) coaches didn't expect to give us much time as they did, coaches are volunteers and time commitment is demanding".*	[229,455]	
Lack of social support	1	*"Thirty-one percent of coaches reported they would not encourage mouthguard use".*	[198]	
Lack of group cohesion (peer support or participation)	1	*"The value of group learning is decreased when some coaches don't participate".*	[455]	
Self-motivation (e.g., lack of interest, boredom)	1	*"Some coaches lost interest" in continuing with an online educational concussion program for coaches.*	[455]	

Themes/ Sub-themes	n studies	Example	References	Relevant theory/model and/or construct/factor
Type of equipment(physical environment)	1	*Some coaches that did not believe headgear was effective in preventing concussion suggested its use could potentially lead to more concussion as the player may: "have a false sense of security", "learn to lead with their heads"; or even take a "kamikaze approach". They were concerned that padding in rugby may evolve to that currently used in American football.*	[175]	
Type of training(physical environment)	1	*Coaches' reported perceived weaknesses of an online program included some drills being too complicated, this was often associated with their belief that they would be too advanced for the level of player.* *Coaches believed that pre-exercise stretching increased the risk of joint dislocations".*	[229,455]	
Lack of skill or education	1	*Coaches indicated that "the biomechanics education seemed too hard to understand and teach, so the coach brought in a power-skating coach".* [455]	[455]	
Confidence and control in implementing injury preventive measure	**1**	*Overall, coaches viewed themselves, the players, or the trainer as most responsible for players wearing mouthguards, not referees. Yet only 26% felt the coach had the greatest influence on players wearing mouthguards".*	[202]	HBM, TRA/TPB, SCT -Self-efficacy -Behavioural Capability -Perceived Behavioural Control
Attitudes towards injury prevention measures and practices	1	*"Over 80% of coaches believed that mouthguards should be worn at all times by athletes, during practice and competitions, while 19% believed that use was only necessary during competitions".*	[199]	TRA/TPB -Attitudes towards a behaviour SCT -Outcome Expectancies

Table 4.11

Summary of atheoretical coach injury prevention studies related to theme factors and injury prevention measure

Themes/IP measure	PPE	General IP	SET	Education	Multi-focused
Injury prevention intention, goals and behaviour/ practices	6	-	3	-	-
Perceived threat/risk of injury and its consequences	7	1	2	-	-
Perceived benefits of using preventive measure	5	-	2	-	-
Reduced the risk of injury	3	-	2	-	-
Enhance adherence	2	-	-	-	-
Improved performance/fitness components	-	-	2	-	-
Improved socialisation (or cohesion)	-	-	1	-	-
Perceived barriers of using preventive measure					
Cost	3	-	-	-	-
Lack of time	-	-	1	1	-
Lack of social support	1	-	-	-	-
Lack of group cohesion (peer support or participation)	-	-	-	1	-
Self-motivation (e.g. lack of interest, boredom)	-	-	-	1	-
Type of equipment(physical environment)	1	-	-	-	-
Type of training(physical environment)	-	-	1	1	-
Lack of skill or education	-	-	-	1	-
Confidence or control in implementing preventive measure	1	-	-	-	-
Attitude toward injury preventive measure and practices	1	-	-	-	-

4.3.5 General methodology, study design and data collection

The majority (82.6%) of coaching injury prevention studies selected in this review have been conducted from a quantitative epistemology. Qualitative and mixed method epistemological research only accounted for less than 20% of all studies in respective categories [230,454]. Cross-sectional studies (*n = 24*) were the most common study designs used within the selected coach studies. Five studies used a cohort design (*n = 5*) [21,23,29,30,46] and two studies used a randomised controlled trial design (*n = 2*) [108,114,454].

Consistent with a prominent qualitative focus and cross-sectional design of coach studies, questionnaires have been by far the most common method of data collection. Most of the studies have also relied on a single source of data collection. Only two studies [124,454] combined two or more different methods in the same study. Of those studies, combinations of data collection were (1) interview and focus group [454] and, (2) questionnaire and observation [124], respectively.

Table 4.12 shows the general methodology, study design and data collection by time period. Overall, there has been an increased trend in the use of quantitative methodology, cross-sectional designs and questionnaires from 1991 to 2014. Only one qualitative study was conducted in the period 1991-1995, and the use of qualitative enquiry (both epistemology and methods) only began to surface again during 2006-2011. Similarly, mixed-methods research has also been sparse overall, with studies only conducted more recently, in the period 2006-2010 and 2011-2014.

Table 4.12

General methodology, study design and data collection by time period (number of articles)

Year Period	**General Methodological Epistemology**			**Study Design**			**Methods of Data Collection**			
	Quan	**Qual**	**Mixed**	**Cross-sectional**	**Cohort Study**	**RCT**	**Q'naire**	**Interview**	**Focus Group**	**Observation**
1991-1995	1	1	-	1	-	-	1	1	-	-
1996-2000	3	-	-	3	1	-	3	-	-	-
2001-2005	4	-	-	4	1	-	4	-	-	-
2006-2010	10	1	2	10	3	2	11	1	2	2
2011-2014	1	2	2	4			1			
Total	**19**	**3**	**4**	**24**	**5**	**2**	**24**	**4**	**2**	**2**

4.4 Discussion

This chapter has reviewed the literature over the past 25 years examining the coach and sport injury prevention. Overall, this research topic is in its relative infancy. Importantly, the review highlights gaps in knowledge, provides rationales for future research and guides practice and policy towards the next steps.

4.4.1 Overview of year and journal

The emergence of coaching science research with a focus in sport injury prevention commenced in the 1990s. Since that time, the coach research specific to sport injury prevention has been slow in developing and has only begun to be more prominent as a research focus in the last decade. Although it is acknowledged that other areas of coaching science research have also been limited [421,437], some possible reasons for the low publication rates in the coaching - sport injury prevention research may relate to: (1) coaching being predominantly volunteer in nature and the lack of funding in this research area; (2) the professionalism of sport shift from the mid 1990s and the importance of sports coaching as a discipline since then; and (3) the lack of focus on the extent to which sport injury prevention and interventions are applicable to, and effective within, real-world sport delivery contexts and settings, until recently [31,116,127,266].

Coaching injury prevention scholars have tended to publish their research in a variety of journals, often dependent on the particular study's disciplinary roots. Given that the area of sport injury prevention has tended to be grounded in sports medicine, epidemiology and biomechanical approaches [28,117], and the predominance of PPE studies in the behavioural and/or coach research area, it is not surprising that the studies identified in this review have been published in dentistry-related journals (for mouthguards) and general sports science journals. It may be that as the field of injury prevention grows in the behavioural/psychology domain, studies are more likely to be published in specific coaching and sport psychology journals, as is the general coaching science research. A recent paper [441] presented at the 12th World Congress of the International Society of Sport Psychology (Marrakesh, 2009) outlined the top 10 journals for coaching science research over the periods 2004 - 2008. These were (1) *International Journal of Sports Science and Coaching*, (2) *The Sport Psychologist*, (3) *Applied Research in Coaching and Athletics Annual*, (4) *Psychology of Sport and Exercise*, (5) *Research Quarterly for Exercise and Sport*, (6) *International Journal of Coaching Science*, (7) *Journal of Applied Sport Psychology*, (8) *The Sport Journal*, (9) *International Journal of Sport Psychology*, and (10) *The Physical Educator*. Interestingly, only one study identified in this review was published in one of these journals, the *International Journal of Sports Science and Coaching*. Other journals of relevance include the *Journal of Coach Education* and may be considered as options for coaching science-injury prevention researchers to submit articles for publication in the future.

Although coaching science research is continuing to be generated, a cautious optimism about the real world impact of the dissemination of this research in particular journals may be needed. Researchers need to consider how this research-evidence is best translated onto the practice-field and directly to the coaches who will potentially be implementing the recommendations [420,427,430,444,473,474].

Understanding how coach injury/sport science researchers can support coaching practice is a task for coaches, researchers and other sport practitioners (e.g., sport and exercise psychologist) [475] . Coaches with little knowledge of the SIP and other related sport science disciplines may be unable to usefully apply research findings unless researchers communicate the applications of their research findings in practical terms [420,473,476,477]. Questions to ask include whether coaches read peer-reviewed scientific journals, and what they can understand. It is also reasonable to ask whether they are more likely to look at multidisciplinary sports periodicals or coach-specific magazines, or to attend conferences to receive updated information. Numerous studies in the general coaching context suggested that research delivered through appropriate forums or coaching clinics, using appropriate lay language, and incorporated into coaching accreditation material, is more likely to be of use to coaches [478,479]. Other studies have examined the information needs and information - seeking behaviour of coaches finding that the primary sources of information were coaching association journals, information stored in private collections, friends, colleagues, sport psychologists, national coaching foundations, playing experience and formal education [474,476,479-487]. Types of coach education (or learning experiences) can occur through a complex mix of formal [483], non-formal [486], informal [484], directed [473,488] or self-directed [423] situations. While it is beyond the scope of this review to explore such applications of research into practice further, coach dissemination and information-seeking behaviours is an essential part of coaching development [440,474].

4.4.2 Coach demographic and contextual features of studies

Most studies have been conducted in the United States, and these were school-based with a focused attention on team sports . Until more studies are conducted it is difficult to provide the coaching community with an accurate picture of injury prevention practices, and the determinants and consequences of such practices across other sports delivery contexts. For example, in the United States most sport is offered in sport systems through educational institutes (high school and college university levels). This is not the case in many countries where community-based sport systems are more prevalent. Furthermore, research with coaches in most individual sports appears to be lacking. Coaching athletes one-on-one versus working in a team/group environment may pose very different injury prevention challenges for coaches and hence it could be assumed that coaching practices and injury prevention behaviours will likely vary in important ways between coaching contexts.

4.4.3 The role of behavioural theory and coach injury prevention research

The role of behavioural theory in coach injury prevention research is currently limited. Despite this, it is a promising sign that there seems to have been an incremental shift in the last 10 years whereby behavioural theory development and application is becoming more cornerstone in an effort to better understand coach factors and influences. From a practical standpoint, for example, such research efforts can assist in the development of target strategies to enhance coaches' capabilities and motivation to take on preventive actions. In addition, researchers and practitioners alike are also increasingly acknowledging the importance of social-ecological contexts, that is the need to understand an individual's (e.g., coach's) behaviour within their social environment, and intervene not only on the individual level but on broader social structural levels [116,127].

The theoretical perspectives that have been adopted include the HBM, TRA/TPB, SCT, DIT, and the RE-AIM framework. Because of the limited use of theory and a greater focus on atheoretical perspectives in coach injury studies, there seems to have been no, or little significant empirical basis for recommending one perspective over the other in relation to coaching injury preventive behaviours, their determinants and effective interventions, at this point in time.

What is known at this point, however, is that most theoretical studies are related to the prevention of LLI [108,111,124,138,158] and concussion [239,467] using either coach education or multi-intervention strategies. This appears to coincide with the epidemiological evidence on LLI [147,489] and concussion [490-492] as significant sport injury problems and recognises the need for complementary approaches to preventing sport injury (i.e., a comprehensive approach that integrates strategies designed to modify individual behaviour and their physical environment as part of a multifaceted, coordinated prevention program).

Most studies based on theory aimed to measure a theory/model, or construct, and guide program design and/or implementation and/to select program measures. According to categorisation by Trifiletti et al., [122] this suggests a low to moderate level of theory application and demonstrates a need to further systematically apply theories and models in coach injury prevention research. A need appears to exist, not only to report the theory and utilise it in an appropriate manner in future research studies, but also provide various behavioural techniques as part of the implications of study findings, and how these are mapped onto theory constructs [401]. This will likely assist practitioners or applied researchers, working directly or indirectly with coaches, to facilitate the development and delivery of safe, sustainable and effective programs on the “ground-level” in real world environments [475].

A number of individual or psychosocial factors such as coaches’ self-efficacy, behavioural intention, knowledge, attitude, and social environment (low player/coach ratio) have also been shown to be significant factors in understanding coach injury-related behaviours and how their injury practice and attitudes can impact on player behaviour in various sport contexts. These constructs arose from the growing number of theoretical approaches used in psychological research of sport injury. This has led to a call in using an evidence-based approach in integrating multiple theories into a unified model that provides a comprehensive framework of the psychology of sport injury prevention. Such a model is advantageous because it not only eliminates redundancy and complexity of the explanation of injury prevention behaviours in sport, but it also outlines the mechanism of how various theories may work for a unified framework of behaviour change, resulting in stronger power. Potentially, the simplified and integrated framework, when being systematically mapped into behavioural change techniques, would be highly useful for coaches to promote prevention practices among their athletes.

It is also important to highlight that various factors in the atheoretical studies were elucidated and are likened to particular theoretical factors. These factors identified in atheoretical studies include: (1) coaches' injury prevention intentions, goals and behaviours/practices; (2) coaches' perceived threat/risk of injury and its consequences; (3) perceived benefits/barriers of using preventive measures; (4) confidence and control in implementing preventive measure; and (5) attitude towards injury prevention measure and practices. These factors provide a further important insight into the determinants of coach behaviours together with theoretical factors that have been identified. It will be useful in future research to be guided by such factors, in addition to the general coaching science research [437] to elucidate findings of new research and applied directions in the sport injury prevention area.

Individual-based theories have recently emerged in coach injury research in an effort to better understand factors associated with coach injury-related behaviours. Theory has also been used to develop interventions that were evaluated in randomised controlled trials, providing information about the theory and also evidence of program efficacy. Unfortunately, given the range of injury types, injury prevention behaviours and the uniqueness of various target populations it is difficult to draw conclusions about the utility of individual-based theories across the numerous coach injury prevention studies. While evidence from a single study can provide useful information about what factors to target or about program efficacy, only multiple studies and replication studies carried out on many different injury prevention behaviours and among different populations can lead to evidence for best practices.

What is needed is substantial research on both the determinants of behaviour and the efficacy of behaviour change interventions using behavioural science theory, methods, and applications. This information would fuel recommendations to researchers, sport practitioners and coaches about the most important factors to address and the program components that are most likely to succeed.

Most noticeably absent from this body of literature on individual based theories are longitudinal study designs and mediator models of analysis, both of which would aid in understanding behaviour over time and influencing factors that account for any change. Nevertheless, this review should enable coach researchers and practitioners in injury prevention to more easily identify potentially useful theoretical approaches to a sport injury problem of interest relevant to the coach.

Research focused at the community level considers organisational settings and their influence and social and injury/health policies [121]. Coggan and Bennet [493] stated that community-based injury prevention "occurs when people and organisations collaborate as communities to design and implement strategies to promote safety, reduce the incidence and/or severity of injury in their population, and reduce the prevalence of injury determinants in the community" (p. 349). An understanding of the functioning of individuals, groups (e.g., sporting teams), organisations (NSOs), large social institutions, and communities is vital in assisting preventive enhancements among coaches. Key questions important to ask might include: (1) how do social systems operate within sport? (2) how do changes occur within and among sporting systems?; and (3) how do community and organisational changes in sport influence people's behaviour and health? [121]. Community models to assist in the understanding of the levels of influence on coaches' preventive behaviours include - Models of Community Organisation and Community Building, Organisational Development Theory, DIT and Communications Theory. To date, two studies applying the Diffusion of Innovations and the RE-AIM have been conducted.

Interventions targeted at the community level are designed to promote injury prevention behaviour change by providing individuals with information and skills to change behaviour through naturally occurring channels of influence in the community and simultaneously to provide a supportive environment that encourage injury-preventive behaviour. Changing community norms also reinforces and maintains safety promoting behaviours. This provides one avenue for ensuring a social context in which an individual will be reminded that the healthier alternative (safer behaviour) is preferred in accordance with community standards and norms.

Community interventions may have four interrelated outcomes. First, they may promote the adoption of injury preventive behaviours among persons engage in the safety or at-risk behaviour. Second, they may help sustain newly acquired injury preventive behaviours and, it is hoped, solidify these changes so that they are maintained over time. Third, they may serve to amplify individual-level program effects over extended periods, reducing the potential for relapse to previous "at-risk" behaviours. And finally, community-level interventions may foster an atmosphere that discourages the initial adoption of high-risk behaviours. An understanding of these broader, pervasive influences may lead to the development of community-level interventions, initiate policy changes, design institutionally based programs, and promote the development of broader, macro-level societal changes.

4.4.4 General methodology, study design and methods of data collection

Whilst acknowledging the general dearth of research related to the coach-injury paradigm, the empirical knowledge base in coach injury prevention has overwhelmingly been guided by: (1) quantitative research epistemology; (2) has been largely based on cross-sectional or retrospective designs; and (3) collected data using questionnaires. These issues have limited the level of evidence regarding the causal relationship between coach behaviour and athletes' injury prevention behaviours and the incidence of sport injury. This is possibly due to the challenges in conducting longitudinal studies or experiments in the context of sport injury prevention given the randomness and multifaceted nature of sport injury. On the other hand, a notable proportion of studies conducted have incorporated or relied on quantitative approaches, whilst qualitative and mixed methods approaches have been largely ignored. However, some recent gradual trends over 2006-2010 indicate that both qualitative and mixed methods research methods are beginning to be utilised and may increase over time.

Overall, a focus on quantitative enquiry has and will continue to provide valuable knowledge regarding coach behaviours and underling factors, it appears important that such enquiry needs to focus on application of theories. A further focus on both qualitative and mixed methods approaches would also not only enables a deeper understanding of the multifaceted interactions involved in the dynamic coaching process, but also an awareness of the contexts in which coaches act, and the influence these context have upon coaches' injury prevention strategies.

4.5 Recommendations for Future Research

A useful body of research, albeit small, does exist and this has scoped the existing research in sport coaching and injury prevention in various sport settings. Despite this knowledge base, we still know very little about coaching-injury prevention practice, good or bad, across a variety of sport contexts, and the limited research is mainly belief-based. It is important therefore to further investigate what and how coaches actually "do", and if injury prevention practices are meshed into their training regimes. This could be done through observation, questionnaires or interviews of coaches, and using a combination of these and other data collection methods. For example, triangulation of field observations of coaches' training practices (including injury prevention practices) and interviews about them maintaining preventive practices could explore the possible differences between what coaches say they do, and what they actually do. In addition, another example of triangulation could be observation (e.g., which could include researchers conducting video analysis) of a coach's delivery of injury prevention training practices to understand implementation barriers or adherence factors (e.g., coaches' communication, reinforcement and feedback, exercise type, intensity, technique etc.), together with interviews. This methodology approach could act as a resource to generate a more in-depth understanding of lived experiences in sport settings and how coaches may construct their coaching behaviours in the interview contexts. Such an approach underpins the remainder of this thesis.

To ensure efforts in preventing interventions can be optimised to ensure safe and sustainable participation outcomes for athletes, obtaining an understanding of determinants and influence of coach injury prevention behaviours based on theories of behaviour change at multiple-levels is crucial [127]. Theories and models can be useful in planning, implementing and evaluating interventions. Theories and models can go beyond basic unchangeable risk factors to answer why, what and how coaches and others can change their behaviour [266]. Theories can be used to achieve the accumulation of generalisable knowledge about the processes of successful or unsuccessful interventions [121,122,127] yet it should be carefully done by a systematic and evidence-based approach such that interventions could utilise multiple behavioural change techniques that have be shown to be effective in modifying the factors that are directly or indirectly related to the target behaviours [130,475]. However, this approach is fairly new in the area of sport injury prevention, an area that has, to date, been largely atheoretical [127]. Given this novelty, it is likely that there will be problems in pursuing a theoretical path, however with persistence and the applicability of theory this is likely to contribute to this field moving forward. New models and wide-ranging methods of data collection may aid in pursuing such work.

It is also important to consider the determinants of coach injury-related behaviours from a multilevel ecological perspective [272,403,494]. Theories that lay emphasis on individual preventive behaviours have an important role to play in our understanding of how to improve behaviours to reduce injury risk and consequences among the athletes and sporting populations [127]. It is important to consider the community, organisational and social contexts to understand where beliefs come from and find ways to change both beliefs and external constraints [495-497].

As highlight in a previous review [127] and other research in sport injury prevention comparison and integration of theories is an important component of advancing theory use [133].

Future research should utilise different methods of research to examine how coaches may contribute to sport injury prevention in diverse ways. Overcoming the challenges in collecting longitudinal data would be an essential step as it allows formal tests (e.g., crossed-lagged panel design, experience sampling method using multi-level analysis) of how the variation of coaches' behaviours would be related to the change in athletes' injury prevention behaviour or injury risk. Similarly, causal inferences could not be made until experimental designs (e.g., a randomised controlled trial) showed that manipulating coaches' behaviours would improve athletes' motivation, intention, or behaviour toward injury prevention. Optimally, longitudinal or experimental research would supplement objective measures of behaviours or psychological constructs (e.g., implicit association tests) and clinical outcomes (e.g., the type and severity of injury), so research could translate the actual impact of coaches' behaviours on minimising sport injuries. Likewise, it is important for future research to pursue qualitative and mixed methods enquiry to fully capture the psychosocial and socio-cultural factors that may determine or impinge on a coach's injury prevention behaviours [498]. Descriptive research could be considered the most elementary of research but it is essential for developing a field like coach-injury prevention, and providing for higher levels of research. A further point made by Gilbert and Trudel [421] concluded that theme fields like coaching science, are developing and by nature require descriptive studies for basic understanding and the accumulation of knowledge.

It seems important that a conceptual framework should be developed to understand the determinants of injury prevention behaviour among coaches. This could also illustrate appropriate strategies aligned with such determinants (or how to devise such strategies) to enhance coaches' preventive practices [273,499-501].

Translating or disseminating coach-injury prevention research evidence into the field of practice is an important step that needs to be taken to ensure that successful theory-based sport injury prevention measures/interventions are adopted and maintained by coaches. Having a strong body of published research that extends current coach injury prevention evidence, and the effectiveness of theory-based interventions is essential in this regard. However, the mere availability of relevant research findings does not in itself guarantee that successful interventions are used in practice. Instead other factors such as formalised support from sporting bodies and training for coaches need to be in place to ensure the successful transfer of research knowledge into practice. While there is some, albeit limited, initial research base on the determinants of various sport injury prevention measures among coaches in different sport contexts, there is also a paucity of research into methods (i.e., behaviour change strategies) for ensuring the wider dissemination and uptake of successful interventions. Intervention mapping [400,401,502] could be utilised as an approach towards this aim, alongside using other behaviour change frameworks [400,401,502].

4.6 Summary and Conclusion

This review examined the peer-reviewed literature that investigates the coach and sport injury prevention research over the past 25 years. Findings from the studies reviewed serve to stimulate further enquiry into the prevention of sport injury and the amalgam of factors in which the coach plays in this pursuit. The review highlights that the analysis of the coach-injury prevention paradigm is largely under-developed and under-researched and further work both from an applied and research perspective needs to be done, the opportunity for additional research remains ample. Although the coach-injury prevention evidence to date is somewhat fragmented and undoubtedly underestimates the complexities of "coaching", an examination of both the theoretical and atheoretical studies in this review lends some initial support to the relevance of the role of the coach, their preventive behaviours (or practices), and determinants of their injury preventive behaviours. Such information, extended in future research and applied in conjunction with behaviour change methods of proven efficacy, can result in training programs that enhance the instructional and interpersonal competencies of coaches, thereby contributing to a more positive athletic environment that promotes skill development and salutary psychosocial and injury outcomes.

This small body of research provides a foundation for further development, implementation, and evaluation of coach-oriented interventions to assist in improving sport injury-related prevention behaviours and reducing the risk of injury among athletes and the concomitant consequences. It is hoped that the review provided in this chapter advances our collective understanding of the "coach-injury prevention paradigm" and cause readers to reflect on their own work, to facilitate better understanding and methodological rigour, and what future reviews of the field may reveal to allow for the identification of effective components to support sport safety efforts, as the major focus of this thesis research will show.

Summary of Section II

This section appraised a range of literature and highlighted limited application of behavioural approaches and theory applications in sport injury prevention research in general and in particular specific to coaches. Few researchers have attempted to investigate factors associated with coaches' adoption and maintenance of SET to prevent LLIs, with a view to support coaches in successfully integrating SET into their training practices.

In chapter 2, a systematic review aimed to investigate the extent to which BSSTM have been used in sports injury research. Amongst the 100 identified papers, only eleven (11% of the total) explicitly mentioned BSSTM. Of these, BSSTM were most commonly used to guide programme design/implementation ($n = 8$) and/or to measure a theory/construct ($n = 7$). In conclusion, very few studies relating to sport safety behaviours had explicitly used any BSSTM. It was recommended that future sports injury prevention efforts will only be enhanced and achieve successful outcomes if increased attention is given to fully understanding the behavioural determinants of safety actions. Appropriate use of BSSTM (including comparing and integrating theories and models) was deemed critical to provide the theoretical basis to guide these efforts. This review's findings identified a major gap in the sport injury prevention literature and formed the initial basis for this thesis. Chapter 3 extended on this work and provide full details and descriptions of BSSTM used in sport injury prevention and applicable studies.

Chapter 4 aimed to systematically review the literature that had examined coaches and cognitive-behavioural aspects of injury prevention in sport. As this research was deemed to still be in its relative infancy or an emerging field of research, it was important to carry out an exploratory scoping review with a knowledge support approach. Selected findings included: (a) 27 peer-reviewed studies being published spanning 23 years (1991-2014), with an increase in publications between 2006-2010, (b) research being published in dentistry and general sport science journals, (c) a primary emphasis on studies conducted in the USA, team-based sports, in school settings, junior/youth coaches, and personal protective equipment, (d) out of 27 papers, only six explicitly used BSSTM and most theories used measured theory or construct ($n = 5$) /guided program design ($n = 4$), (e) studies focused on coach self-report of their safety goals, intentions or behaviour, risk perceptions and outcome expectancies, (f) a focus on quantitative methods ($n = 19$), using cross-sectional designs ($n = 19$) and questionnaire tools ($n = 20$). Based on the evidence, future research was recommended to address some of the methodological and measurement limitations of coach-sport injury prevention literature. This thesis research will address some of the gaps identified, such as using a mixed methods approach and using BSSTM to explore and describe coaches salient beliefs.

As identified previously, while SET behaviours are obviously important in preventing the sequelae of LLIs and ensuring safe and sustainable participation in sport, research is needed on coaches' willingness to adopt and maintain these types of behaviours. Such research needs to clarify whether coaches regard SET programs as an opportunity to make positive changes to their training practices or whether associated barriers or hindrances associated with SET use are such that change will be unlikely. More information is needed regarding which coaches are most willing to make changes (or facilitate changes) and which coaches are reluctant, what prompts coaches to change their training practices (incorporate SET), how coaches approach these types of changes, the strategies they may adopt, and the factors that encourage or discourage them to maintain SET. An understanding of the determinants of SET behaviour change among coaches could inform future research (e.g., theory development, testing strategies for change) and practice initiatives aimed at supporting coaches in making effective changes in their training plans and practices. Research of this nature is new and important. This study will investigate a range of coach beliefs underpinned by a combination of BSSTM, which will be explained more fully throughout subsequent chapters in the thesis.

The next section addresses the research methodology. MMRA (longitudinal survey plus in-depth multi-case study interviews) have been chosen to capture the data needed to fully explore factors that may influence a coaches' SET behaviour to prevent LLIs.

SECTION III

Chapter 5: Methodology and Design

5.1 Mixed Methods Research Approach

A MMRA, applied to a longitudinal design within a larger study in Phase 1, and follow-up multi-case studies in Phase 2 were adopted for this thesis research. A combination of BSSTM were used to explore coach beliefs and the research questions of interest, as outlined in Chapter 1.

The research was undertaken in two phases: Phase 1 consisted of a two descriptive questionnaires (preseason and postseason), and Phase 2 comprised in-depth semi-structured interviews (including document analysis and reflective journal). Information regarding studies in both phases, data collection, data management and analysis is addressed separately in Chapters 6 (Phase 1) and 7 (Phase 2). See Figure 5.1 for a visual model of the mixed methods procedures.

The preseason coach questionnaire was designed to collect data on coach beliefs underpinned by SCT and HBM:

- personal characteristics (e.g., socio-demographic information).
- volitional training behaviours (training planning behaviours - each session, entire season. common training principles used; LLIP prevention strategies).
- coaching goals/intentions to adopt SET.
- risk perceptions (perceived susceptibility and severity of players' LLIs).
- outcome expectations and self-efficacy.

The postseason questionnaire extended the BSSTM framework adopted in Study 1 to give consideration to other salient beliefs that may account for better understanding coaches' integrating and maintaining SET into their coaching practices in future seasons above that explained by the beliefs explored in the preseason questionnaire.

Phase	Procedures	Product
Quantitative Data Collection	• Preseason (2007 & 2008) • Cross-sectional survey (*n=31*) • Postseason (2007 & 2008) • Cross-sectional survey *(n =28)*	• Numeric data, text data (open-ended responses)
Quantitative Data Analysis	• Data screening • Frequencies • Discriminant function analysis • SPSS quantitative software, v. 19 • Coding and thematic analysis • Frequencies • Microsoft Excel spreadsheet	• Descriptive statistics, missing data, normality • Frequency, valid percent • Chi-square, Freidman's • Codes and themes • Frequency
Cases Selection	• Purposefully selecting the coaches for case studies *(n = 5)*	• Cases *(n = 3)*
QUALITATIVE Data Collection	• Individual in-depth face-to-face semi-structured interviews with 3 coaches (2009/2010) • Documents/research literature	• Text data (interview transcripts, document/research literature summaries and matrices)
QUALITATIVE Data Analysis	• Coding and content analysis • Within-case and Cross-case theme development • QSR Nvivo 8 qualitative software • Triangulation of quantitative data and relevant literature (document analysis) • Microsoft Excel spreadsheet	• Codes and themes • Similar and different themes • Cross-case themes reported
Interpretation of Entire Analysis		• Summary of findings (including overview table of findings, limitations and strengths) • Recommendations for future research

Figure 5.1. Visual model for MMR procedures.

The postseason coach questionnaire was designed to examine coaches beliefs underpinned by SCT, HBM and TPB:

- personal characteristics (e.g., socio-demographic information, player-coach status).
- coach goals/ intentions to: integrate SET in their training plans in following season (maintenance beyond PAFIX trial), modify the SET implementation, change common training principles previously used, and use any of the SET exercises.
- risk perceptions (perceived susceptibility and severity of players' LLIs).
- self-efficacy (combined with perceived behavioural control; conceptualised from TRA/TPB).
- outcome expectations (including addition of attitude/subjective norms; conceptualised from TRA/TPB).
- evaluations of facilitators (benefits) and hindrances (benefits) of SET (including SET characteristics)
- socio-structural factors and a range of other behavioural components (coach participation in SET with their teams, observation of exercise-trainer implementation, social support provided from coaches to their players)
- use of open ended questions to elicit other potential self-regulation, facilitators, incentive motivation, emotional coping and cues to action/planning processes and strategies.

In the in-depth case study interviews, coaches were asked questions about:

- personal characteristics (e.g., socio-demographic, education, employment, playing experience, years of coaching, hours coached per week).
- sources of learning (behavioural capability/self-efficacy).
- situational and environmental factors (e.g., coach role responsibilities, team/club climate, team cohesion, interpersonal relationships and support structures, philosophies, goals, training schedules, absenteeism/retention, club-home-work interface).

- risk perceptions related to players LLIs (and injuries in general), past or current experience of coaches' personal injuries playing AF.
- factors perceived to facilitate or impede the implementation and maintenance of SET, how (or if any) they made changes after the trial.
- perceptions' about action planning/cues to action to develop and implement future SET interventions to CAF coaches.

In Phase 1, two cross-sectional questionnaires (preseason and postseason) were undertaken with coaches sampled from CAF clubs in regional and rural locations in Victoria and Western Australia, that were part of a wider National Health and Medical Research Council funded trial project - *Preventing Australian Football Injuries through eXercise (PAFIX)*, as described in Chapter 1.

In Phase 2, in-depth, semi-structured interviews were carried out with a smaller sample of coaches who completed the questionnaires from AF clubs in Victoria. The quantitative data from Phase 1, document analysis and the researcher's reflective journal was triangulated with qualitative data in Phase 2. The research in Phase 1 and 2 was largely descriptive and exploratory in nature, as no other study focusing on LLIP interventions has previously used a MMRA, including questionnaires and a qualitative multi-case study components. The majority of research undertaken in behavioural sport injury prevention has been survey based (see Section II).

An MMRA was purposefully chosen for this research, as it provides relevant advantages to quantitative and qualitative methods in isolation [461,464,465,503-505]. It was utilised to allow the fullest exploration of coaches salient-beliefs underlined by a combination of BSSTM to support multi-focused prevention efforts to effectively integrate and maintain SET interventions to prevent LLIs in CAF. The complementary use of quantitative and qualitative data seemed appropriate for developing a more complete understanding of coaches' volitional training behaviours, motivational beliefs, intentions/goals and other behavioural components through the use a combination of BSSTM. As explained in Section II, coaches' roles and behaviours can be complex, and are influenced by a broad range of factors (e.g., psychosocial, socio-structural) that could not be captured by questionnaire data alone. Given that the nature of coach behaviours and motivations to use SET in this situational-context had yet to be fully explored, such features were particularly important in potentially capturing nuances specific to this population. Without combining methodologies, it is possible to lose significant meaning as to exactly how, for example, a wide range of risk perceptions may manifest in this environment which could significantly contribution to the potential for specific applied recommendations and interventions. It was expected that this approach which inform: (a) future applied research studies, (b) theory development/testing, and (c) successful dissemination of practical interventions, to assist in multidisciplinary and multi-level efforts to prevent LLIs and promote safe, healthy and sustainable participation in CAF.

5.2 Target Population and Sample

The target population in this research consisted of CAF coaches who were opportunistically recruited (convenience sampled) from the PAFIX intervention trial, as described in Chapter 1. For the purpose of the Phase 1, coaches were sampled from CAF clubs in Victoria and Western Australia. The sampling framework for Phase 1 is outlined in Figure 5.2.

A standard clustered randomised sample size calculation [463,506] for the PAFIX larger study was based on player outcomes, ensuring enough player exposures (i.e., playing hours) to demonstrate a reduction in injury rates. On this basis, it was determined that 40 teams would be sufficient to achieve 80% power, therefore the sample size for coach questionnaires in this thesis study was restricted to teams in the RCT.

In stage 1 (Figure 5.2), prior to the commencement of the PAFIX trial and recruitment phase, the PAFIX principal researchers and project managers sought agreement from parent AF bodies, the Victorian Football League and the Western Australia Football Commission, in Victoria and Western Australia (respectively). Parent AF bodies then subsequently assisted in the identification of local AF leagues. In the second and third stages, all clubs from the nominated leagues were invited to participate in the PAFIX trial intervention and then randomly selected for 2007 (with 50% from Victoria and 50% from Western Australia). Those clubs that were not selected in 2007 were informed and invited to participate in the PAFIX trial in 2008. Presidents and coaches for each club were contacted by project managers in each state, initially by telephone to elicit their interest and organise a meeting to discuss and present the project in further detail. Clubs were provided with an information package about the PAFIX (Appendix C). Once clubs expressed a formal commitment to participating in the PAFIX trial, clubs (comprising each of 2-3 teams) were randomised to one of two study arms, either Program 1 or 2. A total of 18 clubs (incorporating a total of 40 teams – e.g., senior, reserves and colts) were involved.

In stage four, recruitment of participants (both coaches and players) commenced at the club-team level, plain language information statements were provided and informed consent was obtained (Appendix H). Recruitment was undertaken at training sessions during the 2007 and 2008 pre-season (January-February) prior to the PAFIX intervention commencing and post-intervention (June-August) periods. Presidents and coaches for each club involved in the study were contacted via telephone (by state project managers) to elicit their involvement and discuss the purpose of the study. A mutually agreed time was then arranged for the researchers to attend football training sessions and conducted formal PAFIX testing and data collection (including coaches questionnaires in this thesis research).

To endeavour to make the recruitment process as successful as possible various strategies were agreed and implemented in each state by the PAFIX research team. The field based epidemiology methodology had been pilot tested and adopted in other sports injury prevention RCT's and prospective cohort studies, and published in the international peer-review literature [71,72,81].

At stage 5, the same clubs were followed up and a mutually agreed time was arranged for the researcher to attend football training sessions.

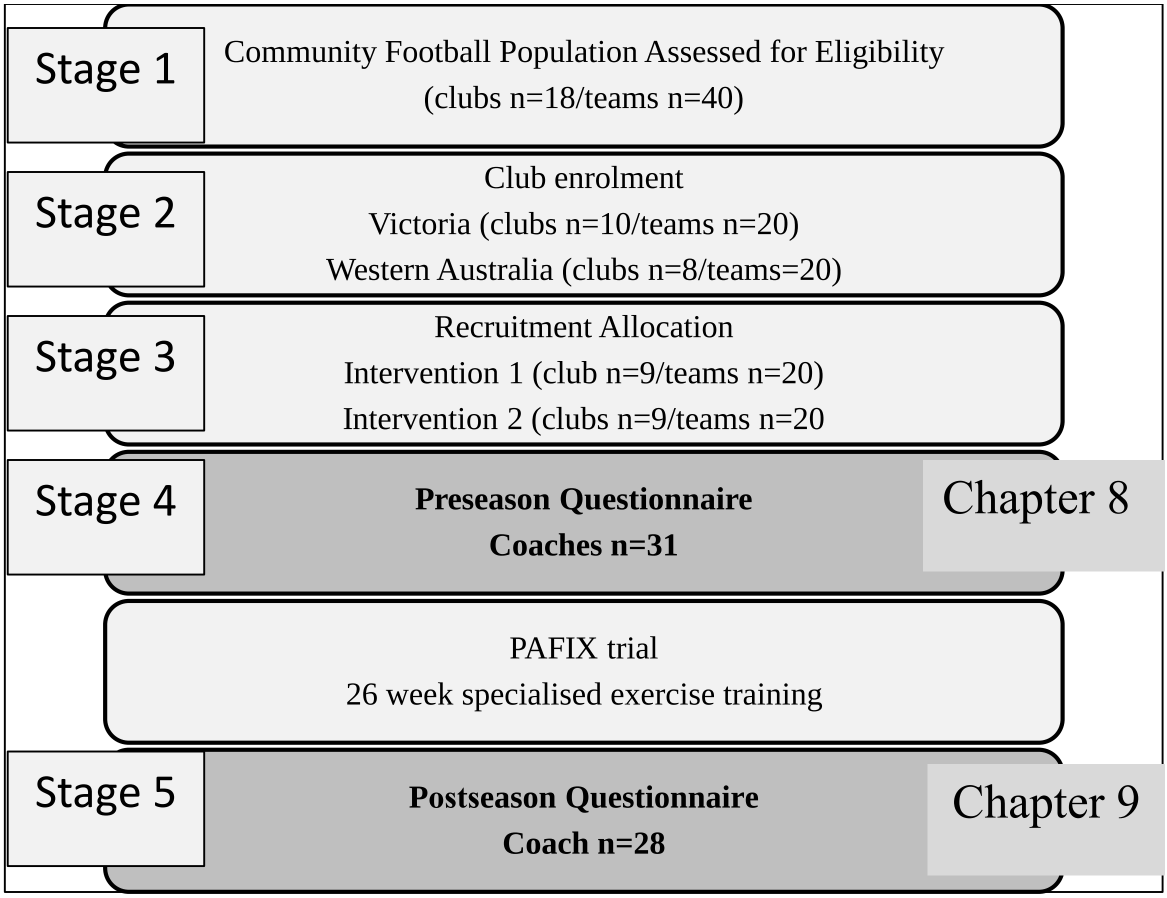

Figure 5.2. Sampling framework for Phase 1

In Phase 2 of the research, coaches were selected using purposeful sampling [507-509]. Such a sampling procedure, which is non-probability in nature [462,463], has been adopted in previous research where participants deemed as information rich are required in order to provide detailed discussions of a specific phenomenon of importance to the investigation [510]. Consequently, in order to be considered for Phase 2 of this study, coaches were required to: (1) have coached at one of the CAF clubs whereby the PAFIX trial was implemented in Phase 1; (2) have coached in the clubs that participated during the 2008 PAFIX trial implementation (including coaches from both study arms); and (3) have coached at one of the Victorian-based clubs during the PAFIX trial.

Five senior coaches from the five Victorian-based community level AF clubs involved in Phase 1 in 2008, were contacted via telephone and email to elicit their involvement in the study and three out of five agreed to participate. One of the coaches declined to participate due to time constraints and the other coach did not respond to the invitation.

Each participant in this phase had “indirect” involvement in the implementation and delivery of the PAFIX trial (2 coaches=Program 1;1 coach=Program 2) in their respective clubs in the 2008 AF season and were followed up 12-18 months post the PAFIX trial (i.e., the end of football season). Additionally, two of the coaches were player/coaches and both participated in the program (not necessarily all the time) or may have just simply observed it or took the time to prepare other training components.

Of the participants, two of the coaches, Geoff and Andrew (pseudonyms) did not continue coaching at their respective clubs the following season (2009); one took a break from coaching, whilst the other was coaching at a different club and league. The third coach, Brian (a pseudonym) did continue coaching at the same club in season 2009, however he resigned approximately half way through the season and decided to take a break from coaching in the short- to medium- term. The profile characteristics, which include brief contextual synopsis of coaches’ stories, are presented in the result chapters to follow (see Chapters 10-13).

Chapter 6: Phase 1 - Quantitative Longitudinal Survey

6.1 Longitudinal Study Design

For Phase 1 of this research (Figure 6.1), a longitudinal study design applied to a larger trial (PAFIX, as depicted in Chapter 1) was used. This included the use of descriptive cross-sectional questionnaires being used to measure coaches volitional behaviours and motivational processes at two time points, approximately 6-months apart: at preseason (TI), postseason (T2), before and after the SET trial - PAFIX was implemented. Longitudinal study designs are similar to repeated cross-sectional studies, but instead of drawing on a new sample from the population at each time-point, the same group of people (i.e., coaches) are followed over time [506,511,512]. This design was seen as advantageous to identify and describe CAF coaching contexts and their beliefs about the factors that may or may not influence SET intervention effectiveness, and in particular, the adoption and maintenance of SET into their routine training practices in future [506,511,512].

At preseason, a cross-sectional questionnaire based on the SCT and HBM as used to understand and describe coaches volitional training practices (planning for training sessions and season, common training principles used, LLIP strategies used in training, and goals for the season) and their cognitive beliefs (self-efficacy, outcomes expectancies and risk perceptions) that may influence coaches training plans or intention formation to adopt and integrate SET programs.

The postseason cross-sectional questionnaire replicated coaches' belief measures (self-efficacy, outcome expectancies and risk perceptions) from preseason, to capture any generalised changes in motivational processes following the implementation of the SET trial, PAFIX. Based on the findings from the preseason questionnaire, the postseason questionnaire also expanded on coach salient-belief measures related to self-efficacy, outcome expectancies and risk perceptions not previously captured and thought to be important in coaches planning their training practices, and incorporating SET in their routine training practices. As such, behavioural and social outcome expectancy measures (which represent the behavioural and normative beliefs underlying attitude and subjective norms as suggested and operationalised by Ajzen), and other underlying coach salient-beliefs about perceived LLI susceptibility and severity, were included and assessed. Measures of coaches intentions to maintain or modify components of it were investigated.

Additionally, behaviour change concepts, based on the SCT were also explored and included:

- coaches participation in SET.
- observation of SET led by exercise trainers.
- reinforcement approaches used by coaches (social support and program feedback).
- coaches' evaluations of socio-structural factors (e.g., facilitators and barriers; and SET characteristics – intensity, frequency and type; exercise trainer qualities).
- open responses to further elicit coaches recommendation about their responses to SET that would increase the likelihood of coaches implemeting (i.e., reinforcement approaches), self-control/behavioural regulation strategies (e.g., self-monitoring, action planning) for improving SET implementation, and emotional coping responses, were also explored.

The preseason and postseason questionnaires are provided in Appendix G.

Phase 1

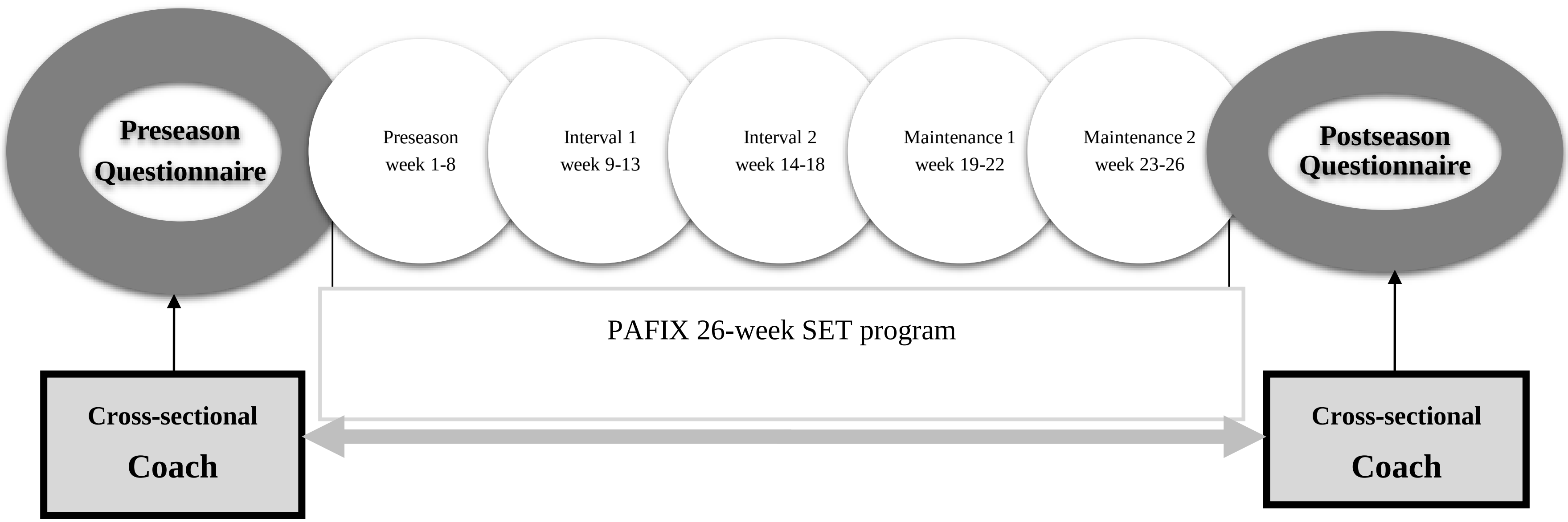

Figure 6.1. Phase 1 longitudinal study design (applied to a larger trial)

Note: Dark shaded area shows the time points cross-sectional questionnaires were used in Phase 1.

6.2 Data Collection

6.2.1 Survey administration procedures

Self-report questionnaires were administered to coaches at respective football training sessions, at preseason prior to the PAFIX trial commencing in February-March in 2007 and 2008, and then again in the postseason (during the end of home-and-away games) following the completion of the PAFIX trial in July-August in 2007 and 2008. Instructions and developed administration checklists (Appendix H) were used throughout the administration period and also provided to research assistants to ensure appropriate questionnaire administration guidelines were followed and reduce collection of biased information [506]. It was emphasised to coaches that they should respond truthfully, and were ensured their responses would be kept strictly confidential. The coaches were advised that the questionnaire involved mostly multiple-choice responses with some short answer responses, and on average, the length of time to complete the questionnaires ranged from 15 to 20 minutes. These instructions were also printed at the beginning of the questionnaire.

If in the instance a coach was not available to complete the questionnaire at the arranged training session due to time or absence from training, an alternative mode of survey data collection was made (e.g., sent via email or postage); a coach was followed-up either via email, telephone or at the next training session to complete the questionnaire. Utilising multiple modes of data collection such as this allowed for maximum response rates to be achieved [506].

Ethics approval (Appendix A) was obtained from both the University of Ballarat (now known as Federation University Australia) and the University of Western Australia. Cooperation and endorsement for the study was also obtained from the state-level AF bodies in both Victoria and Western Australia.

6.2.2 Coach questionnaires

A 52-item and 115–item questionnaire (preseason and postseason, respectively) containing several scales was used to collect information on coaches' demographics, LLIP prevention behaviours (training plans, common training principles and LLIP strategies used), intentions, and socio-structural facilitators and impediments. An identical sample of 45-items was used for the pre- and post-comparison.

The questionnaires were developed based on: (1) modifications of previous questionnaires in AF [123,124,152], other sports [143] general injury prevention research [119,121] and exercise domains [513-519]; and (2) using standard methods and question stems aligned with similar approaches to Conner and Sparks, [520] Ajzen and Fishbein's, [469,521,522], Francis et al., [521] Feltz [523] and Bandura's [524] theoretical recommendations.

The reliability or internal consistency of specific scales was assessed using Cronbach's alpha (α) values as the reliability estimates and ranged from 0.60 to 0.898. A Cronbach α of 0.70 and above is generally considered acceptable [525,526], however, it has been suggested that a Cronbach α of 0.60 would be deemed the lower value of acceptability [527]. Face and content validity was also established as recommended [463,506] and the following steps were undertaken in constructing the coach questionnaires and assessing validity:

(1) The questionnaire objectives and key constructs/factors to be measured were defined,

(2) A search of the relevant measures in the literature was completed and an assessment of whether potential measures met the needs of the study,

(3) Questions were selected, adapted or devised to address the key constructs or factors to be measured,

(4) The drafted questions were reviewed to determine whether they adequately captured the constructs, and whether they met the general rules for questionnaire construction such as being relevant, unambiguous, and in plain language, and whether they are logically ordered,

(5) The draft survey was then reviewed by a panel of five sport injury prevention and two behavioural experts to advise on the accuracy and comprehensiveness of the questions, relevance of the scale items, and readability of the questionnaire. Feedback was obtained and any revisions were completed.

(6) A pre-test or pilot test was conducted with two AF coaches being similar to the intended study sample. These coaches were asked to provide feedback on how they experienced the survey and whether they thought any questions were ambiguous or difficult to answer.

(7) All feedback was then considered, the overall study objectives and methodology, questionnaire length, flow, coherence, structural layout and presentation were reviewed and final changes were made.

6.2.3 Coach preseason questionnaire

Person characteristics. Nine-items were used to assessed demographic/coach information including date of birth, club, coaching position, coaching experience (*i.e. qualifications*, *years of experience, and highest level coached*), and playing experience (*i.e. "have you ever played AF yourself?"*- *yes/no; "how many years did you play?" and, "what was the highest level you played?").* All items were *open-ended* responses, with the exception of one item that was measured on a *yes/no* scale.

Volitional training planning (behaviours). Coaches were asked to indicate, on a *yes/no* response scale, if they planned their training sessions. If coaches answered *yes*, they were asked to indicate if they had a formal training plan for – (1) the season ("*do you have a formal training plan for this* *season?*") and (2) each training session ("*do you have a formal training plan for each training session?*").

Common training principles used by coaches was measured via an open-ended response format asking coaches to *"please specify if their training plan is based on any of the common training principles e.g. specificity, overload, progression, tapering)".* Coaches were also asked if their training schedules were periodised *("is you training schedule periodised i.e. divided into different cycles or periods?*). If coaches responded with a *yes* to this latter item, they were asked to *"please give brief details about the length of each cycle and the components of each cycle".*

Current use LLIP strategies was measured via use of one open-ended question asking coaches *"what specific LLIP prevention strategies do you currently use with your team and why? (If you do not use any specific strategies please state this)"*.

Goals (distal) In an open-ended question format, coaches were asked about their coaching goals (distal) for the season "what is your main coaching focus with this team for the next season?", and "what are your coaching aspirations/ambitions for- *this season, the next years, and the next 5 years*".

Intentions (proximal goals). A 3-item scale was used to assess coach intentions to implement SET. These items were measured on a 5-point Likert scale, ranging from 1 (*strongly disagree*) to 5 (*strongly agree*) for intentions and all subsequent items (risk perceptions, self-efficacy, and outcomes expectations). Higher scores reflected a higher coach intention to implement SET. The intention (proximal) scale had an acceptability Cronbach alpha of 0.889. Overall, the internal consistency of others scale measures ranged from 0.600 to 0.800.

Risk perception measures were aimed at assessing two perceived susceptibility items (e.g., "players are more at risk of LLI now than 10 years ago"), two perceived severity items (e.g., "players with LLI are usually not available to play for one or more weeks").

Self-efficacy. Three self-efficacy items, including one–item measuring learning efficacy- "it is important for me to have a current knowledge of lower limb prevention strategies"; and 2-items measuring self-regulatory efficacy- "I am the best source of information about how to prevent LLI for my players" and "players are responsible for their own LLI") were developed based on recommended guidelines [523,528].

Outcome expectations. Six-items were used to assess outcome expectations for planning training, attendance and preventing LLIs:

(1) incorporating LLI strategies is important when I plan my training sessions

(2) improving team performance is important when planning my training sessions

(3) preseason training is important for preventing LLI in my players during the season

(4) it is important for players to attend training sessions if they want to play in games

(5) LLI cannot be prevented.

(6) LLIs are not a problem for my team

Additionally, coaches' outcome expectations about the importance of 16 AF training skill components (e.g., *warm-up run, warm-up stretches, ball handling skills, kicking skills, ball disposal skills, jumping/landing training, changing direction/side-stepping training*) were also measured on a series of three, 5-point Likert scales. Coaches were asked to indicate on a scale 1 to 5 (1=no importance, 5= utmost importance), how important they thought each of various skill components were for (1) "*your team's training schedule"*, (2) "*your team's performance",* and (3) "*preventing LLI"*.

6.2.4 Coach postseason questionnaire

As in the preseason, the postseason questionnaire measures included intentions, risk perceptions, self-efficacy and outcome expectations. The postseason questionnaire also included additional measures to extend the framework adopted in Study 1 to give consideration to other salient beliefs that may account for better understanding coaches' integrating and maintaining SET into their coaching practices in future seasons above that explained by the beliefs explored in the preseason questionnaire. These additional measures included:

Person characteristics. One-item measure (i.e., "Are you currently a player-coach for the CAF club that you coach?") was included in the post-questionnaire and asked about coaches' player-coach role status.

Planning behaviour intentions/goals (proximal) measures (5-items) aimed at describing coach intentions to integrate SET in their training plans in following season (maintenance beyond trial), or if they would modify the SET implementation, or change common training principles previously used. Three-item measures were replicated from the pre-questionnaire. Other items included "*I intend to include the training skills in the PAFIX program in training sessions in the 2009 season*" and "*I intend to include a modified version of the training skills undertaken in the PAFIX program in training sessions in the 2009 season*". Intentions was also measured using yes/no scales [1 (*Yes*); 2 (*No*); 3 (*Don't Know*)] or [1 (Yes); 2 (No)] with three further questions: (1) "*will you use any specific LLI preventive strategies next season?"*, (2) "*do you think you will utilise training methods employed in the PAFIX in season 2008/09"*", and (3) "*with the integration of the PAFIX do you think you will modify or change the common training principles that you normally use?"*.

Risk perceptions (3-item) was measured by three items assessing coaches perceived susceptibility of LLIs (e.g., *"a players chance of getting a LLIP whilst playing football is high"*), followed by two addition statements concerning the coaches perceived severity of the consequences or outcomes of players LLIs (e.g., *"players with LLI are usually not available to play for one or more weeks"* and *"a serious LLI could have a negative impact on a players life"*).

Self-efficacy (preparatory efficacy=1-item) recommendations by Feltz et al., [523] and Bandura [524]; and combined with *perceived behavioural control* (4-items) measures regarding the initiation and maintenance of SET, based on TPB guidelines recommendations [325].

Preparatory efficacy was included in the post questionnaire to assess coaches' beliefs during the acquisition phase of learning skills (task), or during the preparation time for competition (e.g., coaches' beliefs regarding their ability to perform success … in practice (when first learning a skill). *Perceived behavioural control* was measured with the following items:

(1) "The decision to be involved in the PAFIX was beyond my control",

(2) "Whether I include the PAFIX program in training sessions next season is completely up to me",

(3) "For me to include the PAFIX program in training sessions next season is *easy-difficult",* and

(4) "I am l*ess likely-more likely* to implement a PAFIX in the future if I am provided the training to enhance my skills and knowledge".

Outcome expectancies (attitudes/subjective norms) was assessed in accordance with uniform procedures for the TRA/TPB [521]. *Direct attitudes* towards SET were measured using 5-point bipolar adjective scales as advocated by recommended guidelines [469,521,529]. Two items were used to identify instrumental attitudes (e.g., *wrong thing to do – right thing to do, good practice-bad practice*). The statement that preceded the adjectives was "Overall, I think the SET program is". Indirect 'attitudes' were measured on a 5-point Likert scale continuum, from *strongly disagree* to *strongly agree* (score 1 to 5), and included behavioural beliefs (two items), and outcomes evaluations (two items). These items were adapted for the sport injury domain from previous research [318,323,521,530]. Internal consistency (α) was acceptable for both the direct measures 0.768.

Subjective norms were measured by 5-point Likert-type scales and ranged from 1 (*strongly disagree*) to 5 (*strongly agree*). For measurement of normative beliefs (injunctive items), 8 items were used and coaches were asked the statement "*please indicate whether you believe each of the following individuals/groups agrees or disagrees with you undertaking the training skills in the SET program*":

(1) "I believe the president thinks it's in my best interests",

(2) "I believe other coaches think it's in our best interests",

(3) "I believe players think it's in our best interests",

(4) "I believe the physiotherapist thinks it's in our best interests",

(5) "I believe the team trainer thinks it's in our best interests",

(6) "I believe the club committee thinks it's in our best interests",

(7) "I believe the team captain thinks it's in our best interests", and

(8) "I believe the league thinks it's in our best interests".

Motivation to comply (descriptive norm) was measured with 8 items, coaches were asked to indicate their response to the following statements about what is important to them:

(1) "Doing what other coaches do is important to me",

(2) "Doing what the team physiotherapist thinks is important to me",

(3) "Doing what the president thinks is important to me",

(4) "Doing what the players think is important to me",

(5) "Doing what other coaches think is important to me",

(6) "Doing what the team trainer thinks is important to me",

(7) “Doing what the club committee thinks is important to me”, and

(8) “Doing what the PAFIX trainer thinks is important to me”.

Additionally, a scale item for outcome expectation was included: “I believe it is important the football club is committed to injury prevention”

Self-reported behaviours – participation in SET with team, observation of SET implementation led by exercise trainers, and social support/reinforcement approaches used by coaches towards players.

Socio-structural facilitators (benefits) and hindrances (barriers) of SET implementation, including beliefs about the SET characteristics (intensity, frequency/duration, type of activity and leader qualities). Twelve items (e.g., *do you think the SET benefited your team this football season in the following ways … reduction in the risk of LLI, increased team cohesion*) assessed perceived facilitators/benefits of SET implementation, and six items (e.g., *compared to last season, do you think this seasons training including SET was … too time consuming*) assessed perceived hindrances/barriers.

Other. Open-ended measures were provided on the questionnaire to allow coaches the opportunity to make any further comments about SET in relation to eliciting potential self-regulation, facilitators, incentive motivation, emotional coping and cues to action/planning processes and strategies. These questions included: (1) “*Do you think the SET program could be improved in any way?*” , (2) “*Is there anything else you would like to tell us about the SET program?*”

Throughout the postseason questionnaire, measures were developed in accordance with recommended guidelines [469,521,523,529,531]. Unless stated otherwise, all items were measured on a 5-point Likert scale, scored 1 (*strongly disagree*) to 5 (*strongly agree*). In the case of attitudes and PBC, both Likert scales and semantic-differential scale were used. Internal consistency (α) was acceptable for intentions with a Cronbach α of 0.898, both the direct attitudes measures 0.768, perceived susceptibility 0.751, and perceived severity 0.761, perceived facilitators/benefits 0.741, and perceived hindrances/barriers 0.628. The scale had an overall internal consistency of 0.749.

6.3 Data Management

A Microsoft Access 2007 database was created for use in entering and storage of coach questionnaire data. This form replicated the coach questionnaires and ensured ease and accuracy of data entry and reduced the likelihood of data entry error [463,506].

Responses to open-ended questions were coded thematically using content analysis [463]. Content analysis is an analytical approach that attempts to quantify content in terms of predetermined categories in a systematic and replicable manner [463]. Accordingly, the content analysis involved developing categories or a consistent set of codes, seeking them out from the data and then systematically recording and counting the number of times the categories occurred [463,532]. Themed responses were included as separate variables in the database with a dichotomous coding scheme. Any items in the dataset that were not obviously allocated to one code were discussed between the researchers and coded by consensus about what would best represent the coach responses [463].

All coach questionnaires collected were pre-coded and de-identified prior to double entry into Microsoft Access 2007 to ensure anonymity and confidentiality of coaches' responses [463]. A detailed data dictionary was developed to assist the data entry and coding process. Data management and cleaning [463,532] was undertaken to check for accuracy of data entry, missing values and outliers. The final dataset was transferred to Statistical Package for the Social Sciences (SPSS) version 17.0 for analysis.

6.4 Data Analysis

A combination of descriptive statistics, parametric/non-parametric testing and repeated measures ANOVAs [463,533] were undertaken in the analysis of coach questionnaire data in Phase 1. Before undertaking statistical tests, data for continuous variables were checked for normality by investigating indicators of distribution such as the mean and its relationship to the median, standard deviation from the mean, minimum and maximum scores, skewness and kurtosis. Scatterplots (Q-Plots) were used to examine bivariate relationships between continuous variables [506,533].

Descriptive statistics [533] were used for all variables to summarise coach data. The reliability (internal consistency) [533] of measures was assessed by examining inter-item correlations and corrected item-total correlations, and summarised using Cronbach's alpha coefficients. Cross tabs were tabulated and the chi-square test was used to determine the associations of SET behaviour, intentions and beliefs of interest [533]. Non-parametric analysis [533] was applied to skewed data, Freidman's test was used to compare the importance of training skills for various elements of their (a) Team Training Schedule (TTS), (b) their Training Performance (TP) and, (c) Preventing LLIs (PLLI). A randomisation check was undertaken to compare the questionnaire results (both at preseason and postseason) in coach respondents from the 2 RCT study arms (intervention and control groups) linked to the larger PAFIX trial. However, there was no statistical differences between the 2 RCT arms on any of the questionnaire measures and so data from the two groups has been combined to provide a larger, more robust sample size, on which to base conclusions about coach behavioural parameters. Also, when coaches who did pre-post test (n=19) was compared to post-test (n=28) there was no difference.

Chapter 7: Phase 2 - Qualitative Multi-Case Study

7.1 Multi-Case Study Design

Case studies are a widespread method of choice within social science and coach research used to comprehensively assess programs, events, activities, and processes involving one or more cases over a period of time [461,534,535] . The Phase 2 of this thesis research, incorporated multi-case studies (Figure 7.1) of the perspectives of three CAF coaches. It was undertaken over the course of 2009/2010 after the introduction of the PAFIX trial intervention was delivered by exercise trainers in coaches training sessions, at their respective clubs in 2008.

The overall approach was to:

(1) consider a range of BSSTM,

(2) conduct in-depth semi-structured interviews with individual coaches, and collate/analyse relevant documents and research literature

(3) complete a detailed description of each case (a *case* being defined as a CAF coach) and themes within the case (within-case analysis);

(4) undertake a content/thematic analysis across cases (three coaches at multiple AF clubs) (cross-case analysis), as well as develop assertions or an interpretation of the meaning of the case; and

(5) triangulate multiple sources of data (interviews and document analysis, reflective journal and survey findings from Phase 1) and report meaning of the cases (cross-case report only), and the lessons learned.

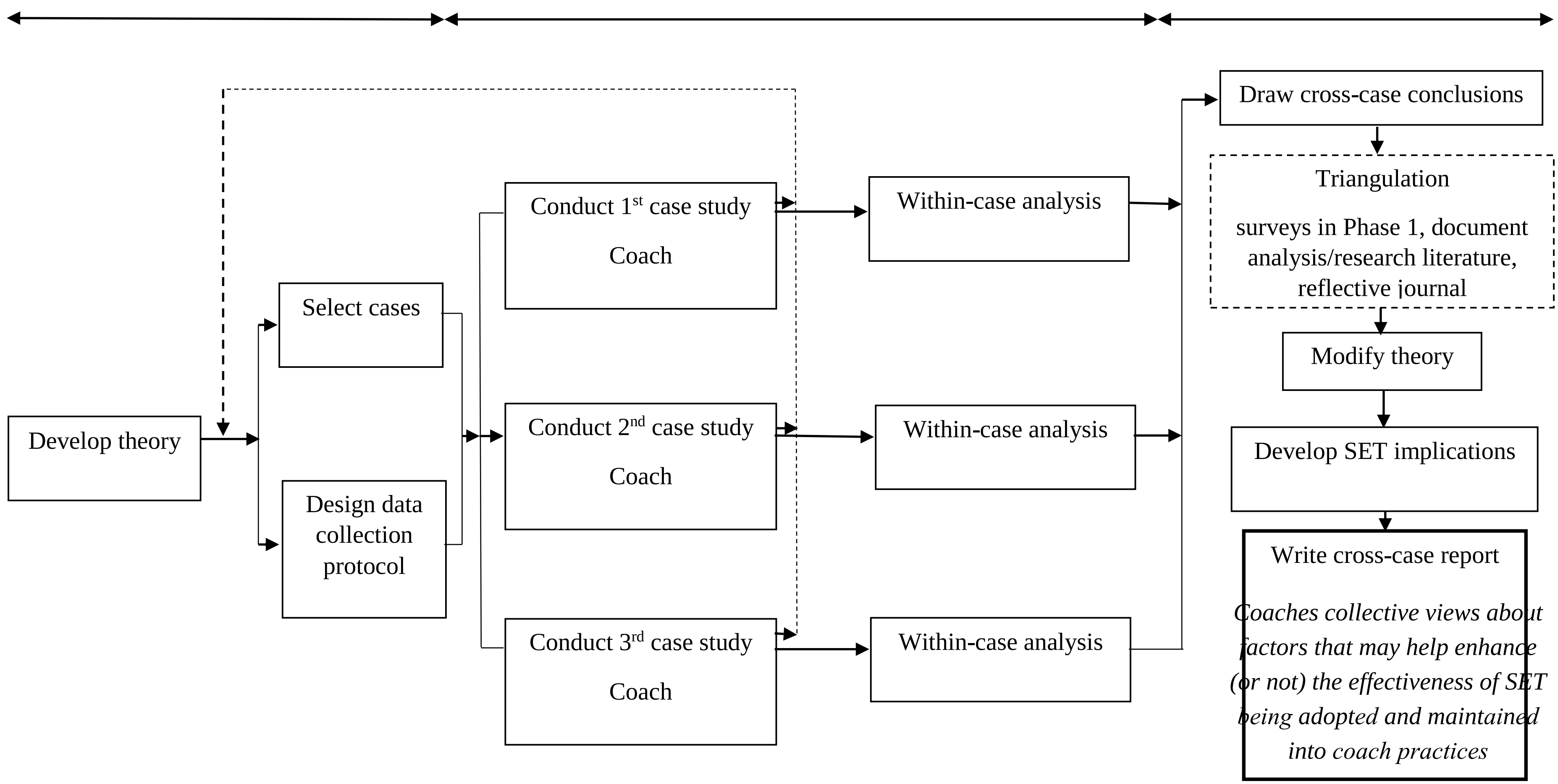

Figure 7.1. Multi-case study approach

Case study research design is increasingly used as an appropriate and flexible approach to research in sport coaching science [423,536-539] and other areas of sport, health and behavioural/social sciences [498,534,535,540-544]. Case study research permits “the detailed, extensive study of a particular contextual and bounded phenomenon that is undertaken in real life situations” [545] p.104. It is known as the “study of particular” [546] and is most commonly applied where the phenomenon of interest is complex and highly contextualised, with multiple variables unsuitable for control [534,535,546-548]. This was a key consideration in its selection as the design for Phase 2. This focus upon real-life context provides methodological flexibility to the case study researcher- approaches to research design can be selected on pragmatic, as well as philosophical grounds [534,535,546-548].

In order to clarify the nature of case study research, it is important to conceptualise it as an approach to research design, rather than a methodology in its own right. Case study research has been viewed as a ‘paradigmatic bridge’ because it is not assigned to a fixed ontological, epistemological or methodological position [545]. Further, case study designs may have explanatory, exploratory or descriptive functions and are acknowledged to have multiple applications to evaluation research [534,535,547]. Whilst more recently case study research has undergone refinements and intensive promotion of its application [534,535,546-548], many features of case study research are drawn from a broad range of research paradigms and usually use multiple methods [534,535,547,549].

Stake [546] has provided three definitional categories of case studies, each with a discrete purpose:

- The intrinsic case study is applied to better understand a particular case for its own sake;
- The instrumental case study utilises the case to examine particular issues foreshadowed in the phenomenon of interest;
- The collective case study is an extension of the instrumental case study to several sites in order to promote a better understanding and, perhaps contribute to theoretical development.

This study is a collective case study as it defined the ‘case’ as the role of the coach in the social context of community-level AF clubs in order to examine the phenomenon of developing and promoting multifaceted strategies to enhance the integration of SET programs to prevent LLI and ensure they are effectively adopted and maintained in real-world practice.

An examination of the rationale for the use of case study research design further demonstrates its suitability for selection in this study. The selected AF coaches and their respective clubs demonstrated a number of characteristics that confirm the selection of the case study design to address the research questions. These are summarised in Table 7.1.

Table 7.1

Rationale	**Example**
Where the phenomenon of interest is complex, multivariate and multifaceted [116,266,429,437,534,535,546,548,550]	There is recognition within the sport injury prevention community that advances in sport injury prevention research are limited by failure to transfer new evidence based findings into widespread delivery of both individual and population health. Coaching is a dynamic, complex and often multifaceted role.
Where the phenomenon of interest cannot be understood apart from its context [131,423,477,536,538,551-557]	In the context of sport coaching, this implies a dynamic relationship between the coach and the environment/context within which they are operating in. For example, research has demonstrated that sport organisations/club practices and cultures influences coaches’ experiences and practices and it is important to understand the extent in which coaches are supported in these environments or how a coach engages and uses strategies to enhance their role or operate effectively.
Where the phenomenon of interest is more completely understood through examining from multiple perspectives [127,549,558]	When “potential users” are involved they may be more amendable to adopting and sustaining specialised exercise programs and researchers can gain a better understanding of the phenomenon of interest to enhance program development and dissemination. For example, PAFIX attempted to preserve the multiple realities of coaches involved in the implementation of SET programs during 2007/2008 football season by using multiple participants across different clubs involved in the SET program initiative.
Where flexibility in research design is required and other designs have limited capacity to answer the research question [549,558]	The triangulation of data from multiple sources can be seen as a particular strength, ‘naturalistic’ generalisations can emerge from cases when researchers provide rich description of action and context. It overcomes some of the difficulties of experimental designs that might be desirable but often not feasible to study programs (e.g., SET implementation programs) and coaching contexts because of the difficulties related to isolating variables and making cause and effect conclusions.
Where theory is underdeveloped or absent [127,549,553]	Coach-sport injury prevention research paradox is a new field with limited theory development, as demonstrated in Chapters 2-4.

7.2 Approaches to Data Collection

For phase 2, semi-structured, open-ended interviews, document analysis and a reflective journal were used to ascertain information specific to the topic of research. Semi-structured interviews are often used in qualitative studies in sport and physical activity research to elicit in-depth accounts of the topic of interest [476,477,498,510,555,559,560]. These sport-specific qualitative studies, for example, have provided in-depth analysis of coaching contexts and coaching experiences on a range of issues in sport that might have gone otherwise untapped.

7.3 Semi-structured Interviews

Each of the coaches participated in an in-depth semi-structured, open-ended interview to elicit verbal accounts. Using this interview structure and open-ended questions helped place the coaches as the expert of their experience, enabling unforeseen topics to emerge [508,509]. This also allowed fluency in the procedure and kept coaches experiences and reality in CAF environments at the foreground, while accounting for the systematic nature of data collection between coaches [507].

7.3.1 Interview guide

Following suggestions by Creswell and others [459,461,509], a semi-structured, open-ended interview guide was developed by the investigator to assess an array of factors relevant to the topic. The interview guide was based on the extant literature, but remained flexible to allow for exploration of coaches experiences and perceptions.

The full interview guide consisted of eight sections pertaining to answering the research questions of interest in this thesis research. The introductory section provided a standard set of orienting instructions and questions designed to initiate discussion and introduce the main topic of the interview, while also building rapport and putting coaches at ease [461]. Issues of confidentiality, reasons for digital-recording, and a statement of coaches' rights were also explained and conferred [461]. This was followed by section two that explored the demographic characteristics of the coaches, including their level of education, occupation, perceptions related to learning and development and “how” and “why” the coaches became involved in AF. The remaining sections addressed and obtained information about coaches’ perceptions, and experiences on a range of factors/topics:

- Section three focused on exploring coaches behavioural capability/self-efficacy (salient-beliefs of learning and development sources), the situational role of the coach, specifically allowing coaches to discuss their situation within the environment of their respective CAF clubs;
- Section four provided the opportunity for coaches to discuss their coaching practices and training behaviours - past, during the specialised exercise program implementation, and post program implementation;
- Section five focused on coaches risk perceptions - perceived susceptibility and severity of players LLI and other injuries; including coaches’ personal injury experiences (past and current);
- Section six concentrated on coaches evaluation and experiences of the SET program trial, including perceived hindrances (barriers) and perceived facilitators (benefits); whether they maintained the program beyond the trial and why/why not; and
- Section seven explored coaches’ views about cues to action/planning that could be used to enhance the adoption and maintenance of SET (e.g., such as PAFIX), specifically allowing the coach to discuss potential action/planning strategies to improve the delivery and quality of SET programs on a larger-scale in the future;
- Finally, section eight, acted as the conclusion, and an opportunity for coaches’ to comment on the interview process and other factors/aspects not discussed.

Where necessary, the interviewer departed from the guide to gain more in-depth descriptions of the coaches’ experiences. When this occurred, the interviewer attempted to avoid biasing or subtly directing the coach’s responses by using neutral non-directional probes [561,562]. For example, after the coaches finished describing their experiences of injury, general probes were used to elicit any other perceived causes to their injury (e.g., "Were there other factors that caused your injury or a player’s injury?"). Specific clarification and elaboration probes had the coaches expand on their responses throughout the interviews [507].

Additionally, when I did not fully understand what was said, clarification probes induced the coaches to repeat and clarify the source mentioned (e.g., "I'm not sure I understand exactly what you mean. Would you please go over that again?"). Elaboration probes were asked after the coaches discussed all of the potential factors associated with the adoption and maintenance of the PAFIX program. The interviewer's discretion dictated the use of any further elaboration probes. A final, general probe was asked before proceeding with the next section of the interview to ensure that coaches had discussed all of the factors that may have been relevant for them (e.g., "Were there any other disadvantages of the PAFIX program that we have not covered?").

7.4 Document Analysis and Reflective Journal

A number of documents were collected and analysed including PAFIX program documents, the information package provided to clubs, the initial research grant application, progress reports, relevant research literature, and CAF club and coach booklets/resources. These documents and related research literature were mapped and used to inform case descriptions and assisted in the development and reflection of case themes during analyses and were triangulated with the theme findings throughout the write-up stage.

In addition, a reflective journal was kept by the investigator [507,563]. Personal observations and opinions were written in the journal after every interview with coaches. Notes on other forms of communication (e.g., phone calls, emails and supervisor meetings) were also added to this journal. It was used to keep track of all aspects of the study, including recording the interactions between the participants and investigator, peer or supervisory debriefing during analysis and write-up stages, and other aspects of interest [563]. Recommendations for use of reflective practice journals were adhered to [507,563].

7.5 Procedures

Following receiving approval from the University of Ballarat Human Research Ethics Committee (i.e., a second approval for Phase 2 was obtained), I contacted coaches at each of the five Victorian-based clubs that participated in the PAFIX program in 2008 (Phase 1) via telephone and email, and invited them to participate in interviews for Phase 2 of this thesis study. At this stage, I introduced the study and explained its purpose (email correspondence included a brief outline and letter of information and consent forms). An emphasis was placed on interviewing a range of coaches at different clubs to fully capture their experiences and the research topic of interest. As a courtesy, the respective clubs (e.g., communication with president or secretary) were also informed of the study and all were eager for the coaches to be involved.

Upon agreement and confirmation from coaches that they were willing to participate in the study, I arranged a mutually convenient time and location (chosen by coaches) to conduct individual face-to-face interviews. At least one week prior to the interviews, an information booklet was provided to the coaches. Provision of the booklet allowed the coaches to familiarise themselves with the content of the interview, along with the opportunity to discuss any queries or concerns with me, as well as facilitating retrospective recall of data [564]. Coaches were advised that the interview could be terminated at any point and confidentiality of participation as well as the contents of the interview was emphasised. Permissions and informed consent were sought from the coaches. Each of the coaches were advised that the interviews would be digitally-recorded, later transcribed, and that I might take notes during the interview.

I conducted all the interviews 12-18 months following the end of the 2008 CAF season. The interviews were conducted face-to-face with the three coaches at several locations, including their residence, or workplace. The duration of the interviews varied between 100-180 minutes (with an average of 125 minutes), this was somewhat dependent on, the coaches' time availability or their knowledge or depth of experiences in their role as a coach. The interviews were digitally-recorded, and later transcribed verbatim by an independent transcriber to ensure a complete and accurate record of data obtained. There were no problems encountered in understanding the recordings and I checked completed transcripts for accuracy. Minor edits were made to ensure confidentiality and improve clarity of the statements. The transcripts resulted in 163 pages of single spaced interview text.

Where available, relevant documentation was gathered from coaches, including samples of training plans or coaching documentation. Such information, as well as other sources of information collated (e.g., surveys in Phase 1, document analysis and reflective journal), were used to corroborate aspects of the findings and were thought to add to the coaches' interview responses, thereby allowing a more holistic and accurate picture to be developed regarding the issues pertinent to this thesis research.

7.6 Data Analysis

Due to the exploratory nature of this phase of the research a combination of both conventional (inductive) and direct (deductive) content analysis approaches were adopted to interpret the data and address the research question/s [464,509,564-566]. The analysis of the interview data followed a number of steps using QSR NVivo TM 2.0 software [567,568] to help organise, store, code and interpret the data. Firstly, each transcript was carefully read (including listening to interviews) several times to achieve a sense of familiarity of the account as a whole, thus gain an overall sense of coaches' experiences and beliefs. Loose annotations were made that identified and summarised initial points or ideas of interest, themes and reflections. Secondly, deductive analysis was then conducted to examine the data in terms of theory-derived concepts generated through the extant literature and interview structure. Consequently, common underlying factors/beliefs from the interview transcripts were clustered with theory-driven themes relevant to enhancing the adoption/maintenance of SET by coaches. This further enhanced the rigour of the analysis through what is commonly referred to as theoretical triangulation [459]. Thirdly, inductive content analysis processes were adopted to find new emergent themes/subthemes reflective of the participants' accounts and theoretical underpinnings [566]. Connections were then made between themes, and those that related to each other were clustered into categories. A summary framework for the categories and themes identified was compiled, which allowed for the overall meaning and emphasis of the coaches' experiences and beliefs. Once all coach interviews had been separately analysed in this way, they were cross-referenced to each other [569]. This deductive and inductive 'interrogation' enabled commonalities and discrepancies across participants (i.e., coaches) to be highlighted [509].

Analysis continued into the writing-up phase with themes organised into a logical narrative account and illustrated using participant quotations. During this stage the data and themes were reviewed again for any information that may have been overlooked, while further defining the themes/subthemes to fully understand the "essence" of each theme. In turn, rich verbatim extracts were subject to the researcher's own overt, analytical interpretations. The goal was to provide a critical and conceptual commentary placing the coaches' descriptions into a wider social context [417,570]. On this basis, tentative inferences were made.

Following further checking, reflection of transcripts, data interpretation and categorisation by the investigator, review and brief consensus discussions about findings was undertaken with an independent researcher, and agreement of the data was reached [571]. Taken together, such steps allowed for a meticulous, meaningful analysis, contributing to the rich rigor of the work.

As part of the collective case study approach the analysis involved three overarching stages, as recommended by [565]:

(a) Within-case analysis – focused on ways to describe, understand and explained what has happened in a single bounded case (e.g., examine possible perceived challenges that could face coaches in effectively being able to implement and maintain SET in CAF environments, that support reductions in the risk of LLIs). This involved developing deductive and inductive theme codes to code individual transcription and documents within each single bounded case.

(b) Cross-case analysis – aimed to identify the processes and outcomes across many cases (i.e., 3 coaches at different clubs), to understand what factors might minimise and maximise the outcome of interest. This approach was important in developing more sophisticated descriptions and a more powerful explanation of the outcome of interest.

(c) Explanatory phases – lessons learnt from the cases and interpretation of the overall findings in a broad context. This assisted in understanding the possible factors and implementation issues and/or strengths and weaknesses of the SET program in relation to broader uptake and dissemination of SETs by coaches.

7.7 Establishing Trustworthiness

Lincoln and Guba [572] highlighted that qualitative research should be judged on its trustworthiness (i.e., trustworthiness could be considered the quantitative equivalent of validity and reliability as reflected in more positivistic approaches to research), which is assessed on four criteria: credibility, transferability, dependability and confirmability. In attempts to account for these criteria, a number of measures were undertaken throughout data collection and analysis procedures in this study. Several recommended steps were taken to account for any potential biases and to meet the qualitative standards of credibility, transferability, dependability and confirmability [459,507]. Based on recommendations from Creswell [461] (p. 209), at least two strategies were used to ensure trustworthiness and/or rigour of this thesis research. Case study research often relies more on data triangulation to strengthen validity and rigour (converging different sources of information – individual coach perspective across different clubs versus documentation, and layering of data collection methods i.e., questionnaires of a range of coaches in Phase 1 and in-depth interviews with a select sample of coaches) and negative case analysis (all responses unique and common coded) to enhance *credibility*, which were deemed appropriate for use in this research to build a coherent justification of themes.

A number of other strategies used to address trustworthiness included:

- Conducting a peer review or external audit – asking a person outside this thesis to conduct a review of the findings, report back and ask questions about the research.
- In order to maintain *dependability* a semi-structured interview guide was utilised and all interviews conducted by the same researcher (author of this thesis), thus reducing inter-interview bias.
- The *transferability* of findings was enhanced through the provision of thick, rich descriptions of coaches' perceptions through the use of raw quotes to convey the findings.
- Finally, *confirmability* was established through keeping an audit trail - all qualitative data have been stored using the software program QSR NVivo TM 2.0 which helps to store and retrieve data as well as facilitating data coding. An Excel spreadsheet was also developed as a database to facilitate a cross-case analysis. In addition, a process of member checking was completed where the final transcripts and results were sent to the coaches for comment regarding whether they provided a true representation of the coaches' experiences and perceptions.

SECTION IV: PHASE 1

Chapters 8 and 9 (p 181-249) have been removed from public display at the author's request.

SECTION V: PHASE 2

Chapters 10-13 (p251-427) have been removed from public display at the author's request.

Section VI

Chapter 14: Overall Summary and Conclusions

The overarching aim of this thesis research has been to enhance the integration of SET into CAF contexts to prevent LLIs and ensure safe and sustainable participation and performance outcomes can be achieved. In particular, it has focused on coaches—their beliefs and behaviours—as key mechanisms to facilitate the effective delivery of SET into CAF training plans and practices in the future. Although this thesis was largely descriptive and exploratory in nature, with small samples, it can be concluded that a complexity of factors can influence a coaches success (or not) in adopting and maintaining SET, and equally a range of behaviour change strategies should be developed, tested and implemented to help coaches, their players, and multi-focused and interdisciplinary-collaborative efforts, to reduce the risks and consequences of LLIs.

This thesis has presented several distinct but interlinked chapters which have:

- reviewed the extent to which BSSTM have been used in sport injury prevention research;
- reviewed and provided an in-depth description (including advantages and disadvantages) of the most common and widely used BSSTM used in SIP including sequentially detailing studies applicable to BSSTM, and provided a summary discussion on cross-cutting themes and issues in using BSSTM in understanding behaviour change processes that may underlie intervention effectiveness in sport settings.
- reviewed the extent, range and nature of the current state of coach injury prevention research and summarised the gaps and importance of these studies' findings;
- at preseason, described the contextual and specific nature of CAF coaches' self-reported volitional behaviours (training plans and goals, common training principles used and current LLI training behaviours), and LLI risk perceptions, outcome expectancies, self-efficacy, and intentions/goals to adopt/use SET;

- at postseason, explored and described coaches’ motivational beliefs (LLI risk perceptions, outcome expectancies and self-efficacy), their generalised experiences and perceptions of SET implementation (including volitional behaviour change techniques used by coaches), their intentions/goals to integrate and maintain SET, and sociocultural and other factors that may relate to successfully integrating and maintaining SET in their coaching training practice and plans in the future season (beyond the SET trial);
- explored how coaches learn to coach, their preferred learning sources and factors hindering or helping their behavioural capability/self-efficacy;
- explored coaches’ biopsychosocial risk perceptions associated with players’ susceptibility (lower or heightened risk) to LLIs;
- explored coaches’ perceptions of the facilitators/benefits and hindrances of SET use and maintenance beyond the SET trial;
- explored coaches’ perceptions regarding the nature and range of strategies (i.e., cues to action/planning) related to maximising coaches’ readiness to facilitate and integrate SET programs, with a view to target and impact the wider-CAF coaching community.

The summary of the chapters key research findings, strengths and limitations are presented in Table 14.1, followed by the overall implications, limitations, strengths and recommendations for future directions.

Table 14.1

Overview of chapter key findings. strengths and limitations, from this thesis

Chapter	Purpose	Methods	Findings	Strengths	Limitations
2	Review the extent to which behavioural and social science theories and models have been used in sport injury prevention research.	Systematic review of the literature. 100 papers included.	• 11 out of 100 studies reviewed explicitly mentioned use of BSSTM. • Most theories identified were individual level theories. • Many common theories in the behavioural literature were not identified, but the most common BSSTM used in sport injury prevention research was the TRA/TPB. • Only two theories were used in more than one study – TRA/TPB and Diffusion of Innovations. • Majority of studies used BSSTM to guide program design and/or implementation. • Of studies that explicitly mentioned use of BSSTM, seven were related to PPE. • Most studies focused on players/athletes (n = 61 studies), other groups included coaches (n = 11), officials (n = 4), and dentists (n = 4). 16 studies related to multi-types of participants.	• Innovative. • Systematic approach adopted and summarised 100 included published papers. • Identified behavioural and social science theories and models that have been used in sport injury prevention research. • Examined and reported how theories have been used. • Reported on future research needs in sport injury prevention research. • Provided an Appendix of studies according to preventive measures that were excluded and did not use theory. • Published in Sports Medicine A* Journal	• Use of specific key words or series of key words may have not identified some studies. • Excluded non-peer reviewed (grey) literature which may have omitted the identification of BSSTM use. • Only peer-reviewed published papers in English were reviewed. • Did not provide full descriptive details of studies/theories, nor their strengths and limitations - other than a quality assessment and classification of theories and how they are used.
3	Descriptive and critical analysis of studies explicitly using BSSTM.	Descriptive and critical review of the literature. 14 papers included.	• A description of BSSTM and their concepts, including the HBM, TRA/TPB, SCT, ASE model, DIT, PRECEDE-PROCEED, Ottawa Charter, the RE-AIM framework and Ecological model was presented. • Limited use of BSSTM. • Individual level BSSTM have dominated the literature. • BSSTM were used in varying ways, from understanding the determinants of safety behaviour, through to testing strategies for change, to disseminating interventions. • No one theory appears to address the complexity that are components of safety behaviours in sport. The importance of a multi-level perspective was highlighted. • It was rare that BSSTM were compared (including using the same datasets and across cultural settings to determine which might be more relevant or appropriate).	• Innovative. • Provided detailed descriptions and critique of sport injury prevention studies using theory identified in chapter 2. • Updated review from chapter 2 to acknowledge new peer-review studies since completion of previous review (2010-2014) and provided Appendix summary table. • Identified strengths and limitations of each of the studies and applicable theories identified. • Reported and summarised themes and future research needs	• Few studies have used BSSTM. • No studies have used the same prevention measure and BSSTM, making comparison and critical reflection difficult. • Implications of findings in studies lacking. • Most studies used cross-sectional designs.

Chapter	Purpose	Methods	Findings	Strengths	Limitations
			• Exploring variables or constructs (e.g., salient beliefs of participants) in detail has yet to be conducted to fully understand determinants of behaviour and advance behaviour change strategies and interventions. • Implications for study findings not clearly aligned with sound BSSTM foundation, and there appeared little consideration for theory revision or development. • BSSTM often used as a loose framework rather than as part of rigourous scientific process.	in sport injury prevention research.	
4	Analysis of coach-specific sport injury prevention research.	Systematic (or scoping) review of the literature. 27 papers of coaches.	• 27 peer-reviewed studies being published spanning 23 years (1991-2014), with an increase in publications between 2006-2014. • research being published in dentistry and general sport science journals. • a primary emphasis on studies conducted in the United States, team-based sports, in school settings, junior/youth coaches, and personal protective equipment. • out of 27 papers, only six explicitly used BSSTM and most theories used measured theory or construct (n = 5) /guided program design (n = 4). • studies focused on coach self-report of their safety goals, intentions or behaviour, risk perceptions, outcome expectancies-barriers and benefits. • a focus on quantitative methods (n = 19), using cross-sectional designs (n = 19) and questionnaire tools (n = 20). • Based on the evidence, future research was recommended to address some of the methodological and measurement limitations of coach-sport injury prevention literature. • Further descriptive studies were recommended to help build the coach-sport injury prevention research base.	• Innovative. • Systematic and scoping approach adopted and summary of 27 published papers. • Provided an analysis of the coach injury prevention research (what do we know?) and identified research gaps (what do we need to know?). • Detailed literature over a 23 year period. • Extended and updated systematic review in chapter 2, which identified only a small proportion of studies had examined the coach in sport injury prevention research. • Reported on future research needs in sport injury prevention research.	• Limited studies related to the coach and sport injury prevention. • Use of specific key words or series of key words may have not identified some studies. • Excluded non-peer reviewed (grey) literature which may have omitted the identification of BSSTM use. • Only peer-reviewed published papers in English were reviewed.
8	to explore and describe coach self-reported volitional beahviours, intentions/ goals and motivational beliefs	Cross-sectional survey. n = 31 coaches. Outcomes measures: Measured coaches self-reported beliefs based on the health	• Overall, 58% of coaches reported using LLIP strategies with their team. • Training strategies reportedly used by coaches, included warm-up, stretching, agility/sprinting, proprioception training and cool down. Fifty percent of coaches indicated they did not use any LLIP strategies, and did not include injury prevention (explicitly) as part of their season coaching plans. Notably, whilst most coaches planned their own training sessions, only 69.2% of coaches had a formal training plan for the entire season. Aligned with premises of SET, over 70% reported using common training principles (e.g., specificity, periodisation). In general, most (90%) coaches' intentions towards SET being implemented into their training sessions were favourable.	• The assessment of LLIP behaviours and factors that may optimise coaches SET usage. • Examination of multi-factors of coach contexts LLIP behaviours and coach perceptions of LLI risk and self-efficacy.	• Beliefs measures may have not fully captured the full extent of coach beliefs to tailor SET intervention development and effectiveness. • Cross-sectional design. • Generalisability of results. • Beliefs measures may have not fully captured coach beliefs to enhance SET intervention design and effectiveness.

Chapter	Purpose	Methods	Findings	Strengths	Limitations
		belief model and social cognitive theory constructs. 52 item scales. Descriptive statistics.	• Coaches' perceived threat towards their players' chance of sustaining a LLI (perceived susceptibility) and their beliefs about how serious a LLI, and its sequelae (perceived severity) are, was high. • Generally coaches perceived it was of benefit to incorporate LLIP strategies when they plan their sessions. • Whilst it appeared that coaches believed it was important to have a current knowledge of SET and preventing LLIs (learning efficacy), many of them lacked the behavioural capability (knowledge and skills) and self-efficacy (preparatory efficacy) to implement SET, and that they perceived other situational-environmental factors (e.g., player attendance at training) were important to consider in effective SET implementation outcomes.		• Coaches were not asked if they had received any previous education on injury prevention strategies for CAF players as part of their training as coaches. This information would shed more light on factors that influenced whether a coach utilised LLIP strategies or a SET program. Though anecdotal reports suggest training such through formal means, at the time of this study did not incorporate SET education for coaches specifically.
9	to explore and describe coach motivational beliefs, their generalised experiences and perceptions of SET implementation (including volitional behaviour change techniques used by coaches), and the factors that may relate to successfully integrating and maintaining SET in their coach training practices and	Cross-sectional survey. n = 28 coaches. Outcome measures: Measured self-reported coach beliefs based on the health belief model, theory of planned behaviour and social cognitive	• The main findings indicated, in general, that coaches' intentions to implement and maintain SET in their training sessions was favourable. Coaches also indicated they intended to change or modify the SET and/or SET implementation process. • Observational learning (i.e., vicarious experience) of the SET was perceived to reinforce positive beliefs about SET. • Similar to the findings from study 1, coaches' perceived susceptibility to, and perceived severity of their players experiencing a LLI was high. Additionally, salient beliefs associated with perceived severity were identified (in comparison to study 1), extending perceived severity indicators. • General strong agreement that there was numerous benefits of incorporating SET into their training sessions. These included reduced risk of LLI, increased performance, team bonding and team fitness. SET implementation also decreased coaches' environmental stressors and enhanced their coping resources. • No pertinent barriers were reported (or anticipated) by coaches, however, suggested improvements included (cues to action / action planning): collaboration, feedback and reinforcement approaches, education (or behavioural capability), and beliefs about situational-environmental factors • Coaches' attitudes towards SET being implemented and incorporated into their training sessions were generally favourable. A small minority of coaches expressed uncertainty about the SET	• Measured multiple factors related to coach beliefs and enhancing the effective delivery and maintenance of SET. • Several important factors and/or salient beliefs were identified. • Provided further evidence in understanding coaches' decisions to implement and maintain SET, and extended and refined study 1 findings. • Explored and identified coaches experiences of SET implementation in their teams by an assistant coach/ specialised exercise trainer did not significantly alter a range of coach beliefs.	• Cross-sectional design • Generalisability of results • Small sample size • Loss of participants at follow-up • RCT was not directed explicitly at manipulating coach behaviours (other than modifying their warm up component of training) and other outcomes measures, causal inferences difficult to determine. • Direct approach (exercise trainer-led rather than coach-led), per se, might have been an issue

Chapter	Purpose	Methods	Findings	Strengths	Limitations
	plans in future seasons (beyond the trial)	theory constructs. 115 item scales. Descriptive stats, frequency, valid percent, chi-square and Freidman's.	program, or indicated it was the wrong thing to do and bad practice. • Subjective norms of coaches were also generally positive towards SET. It was normative among coaches that the team trainer, physiotherapist, other coaches, players and team captain were important in coaches' decisions to implement SET. In addition, coaches were more likely to be motivated to implement and maintain SET by what their players thought, followed by the team physiotherapist, other coaches and team trainer. • Coaches' initial control beliefs about the decision to implement the SET was variable, with 50% of coaches perceiving they had high control and 45% having less control. As for coaches maintaining the SET program, a high proportion indicated that including the SET program in their training practices in the next season was completely up to them, and that it would be easy for them to implement. Regulatory self-efficacy beliefs were generally low, most coaches believed they were not the best source of information for their players in preventing LLIs, and perceived that it was the player's responsibility to prevent their own LLIs. There was also varied findings in coaches' preparatory efficacy (or similarly, behavioural capability), in that coaches varied in their confidence that they had the knowledge and skills to implement the SET for their teams. Importantly, coaches had a strong sense of learning efficacy, indicating they had a strong sense of investing effort in practising (or mastering) the skills needed to incorporate SET into their training sessions. • A range of environmental (social and environmental) and situational factors were established by coaches' self-reports which could either have a direct or indirect effect on their implementing and maintaining programs. • No significant differences were found on any outcome measures before-and-after intervention.		
10	Explored generic learning / information sources (behavioural capability) of coaches	Multi (collective) case study, semi-structured interviews n = 3 community level AF coaches	• Coaches sought information from many different sources • There was a reliance and preference for learning situations that were informal • Informal sources included - playing and coaching experience, learning from significant others (past coaches/mentors, peer or assistant coaches, interactions with payers, family and friends, sport science and other health professionals), gaining information through resource materials and the internet, and observation of elite training	• Innovative, no other study has investigated the generic learning of CAF football coaches to inform sport injury prevention research, theory and practice.	• Only explored more generic sources of learning, did not explore sources explicitly specific to LLI (other injuries) or SET. Though notably it was found in previous studies in this thesis that coaches are not aware of SET etc., and formal coaching certifications (at the time of the this study,

Chapter	Purpose	Methods	Findings	Strengths	Limitations
		Within-case and Cross-case analysis (reported cross-case only)	• Implications for developing behaviour change strategies and interventions to support effectiveness of SET, and its use		document analysis) did not incorporate SET in their certification programs nor did they seem to be other forms of education/training associated with SET. what about LLIs? - coaches aware of this mainly from personal experience, one coach had not sustained many injuries and admitted he was not too knowledgeable about LLIs and would need further support/education in this regard. • Retrospective.
11	Explored coaches risk perceptions (perceived susceptibility) of players LLIs	Multi (collective) case study; semi-structured interviews n = 3 community level AF coaches Within-case and Cross-case analysis (reported cross-case only)	• Coaches believed many risk and protective factors were associated with players' LLIs. • The main themes/factors discussed by coaches were biological and physical, though there was some awareness of psychological and sociocultural factors. • 10 subthemes including biological- preparation quality, strength and conditioning, prior injury, recovery and fatigue status; physical- nature of the games, ground and surface conditions/maintenance, weather; psychological and sociocultural -history of stressors (including life evens, daily hassles, everyday problems), potential risky behaviours, fair play and rules of the game, and coaching quality were identified. • A major focus mentioned in relation to most risk and protective factors was 'coach behaviours' (or quality of the coach's behaviour), supporting the focus of a coach's role surrounding injury prevention efforts in combination with other interventions. • It was highlighted consideration needs to be given to a range of risk and protective factors (e.g., not just biomechnical factors). As such, if it is the case that the focus is on one factor alone in isolation (e.g., identified biomechanical or neuromuscular risk factors), without considering the multiple factors that interplay and underlie player susceptibility to injury, it is likely that prevention interventions will not be as effective as they could be in preventing injury and ensuring safe and sustainable participation in CAF.	• Understands CAF coaches' salient beliefs about player LLI risk and protective factors from a Biopsychosocial perspective. • Expands risk perceptions in quantitative section - and aligns with using Wiese-Bjornstal's pre-injury model to understand coaches' beliefs about players' LLIs. • Innovative, no other study has done this.	• Did not explore coaches' subjective definition of LLIs. • Retrospective

Chapter	Purpose	Methods	Findings	Strengths	Limitations
12	Explored coaches' salient beliefs about facilitators (benefits) and hindrances (barriers) of SET	Multi (collective) case study; semi-structured interviews n = 3 community level AF coaches Within-case and Cross-case analysis (reported cross-case only)	• 10 and 12 themes, respectively, identified related to facilitating and hindering SET implementation. • Coaches' beliefs in the efficacy of SET (advised action) to reduce risk or seriousness of the impact of LLIs was enhanced by coaches' vicarious experiences of SET. • Other factors included non-injury benefits, for example, provision of additional support for the coach in their role, coach learning and development, improvements in players' physical and mental performance, and development of the game. • Hence optimising coaches' acceptance and positive response to the recommended SET. • Some barriers included: the absence of role modelling, SET trainer self-efficacy, reinforcement principles, time demands, player attitude, player absence or lateness to trainer, program lack of modification or adaptation, coaches' latitude-control, and other coach role-related factors. • Highlighting barriers were important and may need to be assessed individually both for prediction of SET behaviour and identification of the most relevant concerns to address in interventions and different coaching contexts.	• Provided the first qualitative data set from a coach perspective in CAF related to implementation and evaluation of SET in preventing LLIs. • The qualitative data presented here did complement and extended the quantitative data in Phase 1 of this research which has considerable potential for directing future research and helping practitioners who seek to design effective SETs.	• While each participant (i.e., coach) had been exposed to SET as a coach or player-coach in some way (though variable), the extent to which the data generated from just "one" viewpoint accurately captures the implementation and maintenance processes and evaluation is uncertain. • Retrospective
13	Explored coaches' beliefs about cues to action / action planning strategies to support community coaches' readiness to use SET	Multi (collective) case study; semi-structured interviews n = 3 community level AF coaches Within-case and Cross-case analysis (reported cross-case only)	• 14 themes identified by coaches to support action planning/cues to action. • Overall, coaches identified a range of strategies at the individual, team, community and wider systems level. • These strategies were perceived important to capture coaches' awareness of LLIs and SET, provide coaches with how-to-information, and reinforce or support coaches' intentions and behaviours to incorporate and maintain SET in their training sessions. • Such strategies suggested by coaches included coach education, policy drivers, overcoming potential problem areas/barriers (coping planning), a try before you buy approach, presenting an empirical basis and guidelines for SET programs (based on evaluation of SET programs), forming strategic collaboration and working in partnership (e.g., researchers, AFLCA, leagues and coaches), communication and social marketing, public meetings, development of a coach hotline, and targeted multi-focused approach within clubs to educate "everybody" (safety is everyone's responsibility), and promote SET.	• Provided the first qualitative set of data to explore coaches' beliefs of cues to action/action planning to support the effective wider-adoption and maintenance of SET to prevent LLIs among coaches in AF. • Complemented and extended findings in the quantitative section. • Build on theory applications.	• The extent to which the data generated from just "one" viewpoint accurately captures the implementation and maintenance processes and evaluation is uncertain. • Retrospective. • Did not fully explore the when, where, how and what to do in the face of obstacles

14.1 Implications

14.1.1 Theoretical implications

By considering and examining factors contributing to the development and maintenance of SET within this thesis, it is possible to move beyond the largely descriptive line of enquiry and facilitate theory development, testing and guiding intervention design. This is likely to further support understanding of a complexity of factors that are likely to not only predict coaches' self-efficacy, intentions or training practices to integrating and maintaining SET, but also assist the development of behaviour change strategies.

The use of multi-theories such as the HBM, SCT, TPB, Wiese-Bjornstal's biopsychosocial risk model (and other relevant constructs) has allowed the identification of salient mechanisms and processes underlying behaviour change. While further research on larger coach numbers would be helpful, the factors identified in this thesis can be mapped to behaviour change techniques for implementation by coaches in increasing their players' participation in SET. The evolution of theory-based behaviour change interventions in SET programs should also adhere to recommendations for clear reporting of behaviour change techniques [273,500]. A recent advance in psychological theory-based approaches to behaviour-change interventions has been the development of taxonomies of unique behaviour change techniques. These have been shown to empirically impact on behaviour through the mediation of the theoretical construct the technique is purported to change [273,836-838]. The techniques can then be used for interventions to promote SET preventive behaviour.

Furthermore, based on linking all of the findings from all stages of this thesis and other empirical literature/work, a new conceptual model of coaches' behaviour change for incorporating and maintaining SET in CAF could be developed. This would be deemed unique in that it could detail factors and processes from this research identified to be crucial factors and processes in enhancing the effective integration and maintenance of SET to prevent LLIs. The model can serve as a guide for researchers in developing future studies on the determinants of SIP behaviours and may form a template for applied practitioners in the development of effective interventions that will promote preventive health/sport participation. Therefore, one of the key intentions in developing an integrated model is not only to facilitate the identification of variables linked to SET behaviours but to also highlight the factors that should be targets for effective intervention within situational-contexts.

14.1.2 Practical implications

The outcomes of this thesis have many potential applications for improving preventive SET programs in CAF. Broadly, and from an applied perspective, describing coaches' beliefs, intentions and behaviours relating to the effective implementation and maintenance of SET will provide and expand the knowledge of those who work with teams and players in CAF clubs. This would include coaches themselves, players, sport trainers, sport and exercise psychologists, exercise physiologist, strength and conditioning coaches, and other sport injury and health scientists. It may also assist coaching associations (e.g., AFLCA) and other training bodies/organisations, to better understand the role of the CAF coaches and support future developments (e.g., cues to action) in enhancing the adoption and maintenance of SET programs to prevent LLIs. Furthermore, coaches who have not vicariously experienced, or have not been exposed to, SET may benefit from reading about the experiences and perceptions of coaches in this research. This information may apply meaning to the importance of implementing and maintaining SET in their respective training sessions and football environments to ultimately prevent LLIs and support ongoing participation and other beneficial outcomes.

14.2 Strengths of the Research

1. Literature Reviews - In the context of this thesis, the series of literature reviews presented are an essential component of evidence-based practice, and were of primary importance in shaping and informing this thesis research. In addition, the published systematic review "The extent to which behavioural and social science theories and models in sport injury prevention research", for instance, has also seemingly had a significant impact in strengthening and advancing

research applying BSSTM in SIP. This is evidenced by numerous citations by researchers in the area (including at international conferences, and in peer-reviewed publications and books) and knowledge that it has guided the initiation of a number of implementation research projects and collaborations internationally.

2. Application of theory – A particular strength of this research in assessing self-reported coaches' beliefs, intentions and behaviours, was the application of a combination of BSSTM. This improves and extends previous research whereby the use of such theories and models has been largely non-existent [127].

3. Use of a Mixed Methods Design – A mixed methods research design was employed and involved both quantitative and qualitative methods. Importantly, mixed methods approaches have been acknowledged by several scholars as one of the most viable ways of examining complex psychological and social phenomena [464]. Several rationales for combining quantitative and qualitative data collection and analysis methods have been described in the broader literature [423,437,444,555]. There is little evidence of the application of mixed methods in sport injury prevention research in general [127][127]and more specifically relevant to this thesis, which is applied to coaches and injury prevention [127]; also see Chapters 2-4. The use of both quantitative and qualitative methods included; (a) being able to complement and elaborate the results from one method with the other by extending and combining the results to produce a more complete analysis (e.g., qualitative elaborated and extended quantitative findings); (b) identify possible variables or constructs that may be subsequently measured through the development of a new instrument or extend existing instruments; and (c) examine the applied relevance and usefulness of combined data.

4. Related to the abovementioned, the use of multi-case studies overcame some of the potential difficulties of the longitudinal design within the larger RCT study whereby the feasibility of isolating variables and making cause and effect conclusion can be difficult. Multi-case studies

considered the strengths and challenges of each program and allowed for triangulation of data from multiple sources (e.g., three coach interviews, questionnaire data from Phase 1 and document analysis/relevant theory and research literature). This allowed greater confidence in the research findings, as compared with findings derived from the use of a single methodology and allowed exploration of a range of coach salient beliefs, and of considering the integration of SET programs in context.

14.3 Limitations of the Research

The following section summaries specific limitations associated with this research that has been highlighted in each chapter previously.

1. While the data is drawn from a population-base of coaches in various CAF leagues (n=5) in Victoria and Western Australia, whose clubs (n=10) were involved in a wider-research study (RCT), it is important to acknowledge obvious limitations to the generalisability of these findings. In phase 1, the response rate to the questionnaire was 84.0% and 81.5% respectively for pre and post questionnaires, these results may, however, be unrepresentative of the overall AF population. They were collected from a small proportion of AF coaches in Australia and may not reflect the behavioural practices of all coaches or other coaches' beliefs associated with adopting and implementing SET at other clubs. Relatedly, a further limitation is related to the characteristics of the sample of coaches. For example, in follow-up interviews the sample of coaches was based on only three clubs. Potentially the influence of other coach characteristics, the club culture or other factors may systematically influence results such as coaches' safety behaviours or perceptions. The findings therefore may only be applicable to these three clubs. Though at the same time, the mixed methods approach and triangulation of data should have served to reduce such limitations.

2. While each coach had been exposed to the SET as a coach or player-coach, the extent to which the data generated from just “one” viewpoint (i.e., coaches) accurately captures the implementation and maintenance processes and evaluation could be questionable. For example, players, SET trainers, football managers or presidents may have a differing view to coaches, and this may lead to contrary understanding about the dynamics of incorporating SET and maintaining it in community football settings.

3. The cross-sectional nature of this research (Phase 1) precludes drawing causal inferences regarding the relationship between the predictor variables and SET program adoption and maintenance. However, the descriptive nature of this research is a strength for basic understanding and accumulation of knowledge in this new area of research.

4. As a key aim of this study was to examine coaches’ beliefs (e.g., risk perceptions, self-efficacy) and intentions/goals at postseason (after their experiences of an exercise-trainer led SET program) to integrate and maintain SET programs at beyond the trial, and not actual behaviour. It would have been interesting to determine to what extent the behaviour change models used in this study predicted actual behaviour of coach-led training sessions in the following season through a combination of direct observation of training sessions and self-report. However, it was beyond the scope of this thesis. Notably though, in follow up semi-structured interviews, coaches did indicate maintaining SET or not, but this was not validated with direct observation. Nonetheless, use of self-report intention as an outcome measure is a common practice when utilising behaviour change theories such as those utilised in this study. For example, several studies that have applied the TPB in other behavioural settings have indicated a correlation between intention and behaviour, where the interval time was more than 1 year and even up to 15 years [606].

5. Though multiple BSSTM were used to understand coaches’ beliefs, there is a possibility that the coach questionnaires used in this research did not tap into important processes,

mechanisms or salient preventive beliefs. This could impact successful outcomes being achieved in future intervention efforts. Though in-depth multi-case studies, exploring coaches salient beliefs on a number of levels and likely have overcome this concern.

6. The data from coaches from two separate PAFIX RCT arms were considered together. It is possible that there could have been very different experiences in some of the coaches from the different study arms and this would be lost, when data was combined. However, a test for equivalence across groups in the qualitative phase was undertaken and showed that there was no significant difference in the responses from the two groups. So this would be expected to be a minor issue, if at all.

7. Reliance on retrospective accounts from participants (post survey and follow-up case study interviews with coaches) was a further limitation. Retrospective accounts are inherently limited by objective and subjective performance outcomes that can influence an individual recall of past experiences [800]. For example, the interview data relied on the recall of coaches' SET implementation experiences, which could have been variable due to differences in coaches' roles (e.g., coach only or coach-player), and whether they observed or actually participated (i.e., completed the SET with their players) in the SET program. The coaches' recollections of the SET implementation could have been distorted as a result of the time lapse between the intervention and the conduct of the interviews; although this situation perhaps afforded them time to reflect upon the trial and implement the program themselves (or not) in their training sessions. In regards to the interviews in this study, coaches were recalling information from 12-18 months post the SET implementation, thus some coaches may have found it difficult to accurately capture factors (mechanisms or processes) that influenced the effectiveness of implementation. However, noteworthy coaches were able to generally report key factors relevant to the trial implementation (there was a sense in some instances implicit processes may have occurred without coaches' awareness). Conducting follow-up interviews,

on the other hand, also allowed coaches to report on aspects such as; (a) the maintenance of the SET beyond the trial phase, (b) whether they were still coaching at the same club, and (c) if they continued coaching in general. This information provided further evidence associated with factors that need to be considered in the development of SET program maintenance (e.g., turnover a factor in maintaining programs).

14.4 Recommendations for Future Directions

The following recommendations are made for future directions:

1. Conclusions from this thesis study rest upon CAF coaches' perspectives only. Future research should also focus on the perspectives of other key individuals associated with SET program adoption and maintenance and preventing LLIs, such as players who undertake training and administrators/club presidents who may have influence associated with club structure. Their philosophies, experiences, and views are important to more fully understand and enhance specialised training program training effectiveness. This will reduce the risk of LLIs and ensure sustainable safe participation outcomes within the CAF setting. Indeed, coaches' behaviours are not unidirectional and consideration needs to be given to the multidirectional (e.g., players' attitudes or behaviours on coaches' attitudes or behaviours and vice-versa). It is hoped that obtaining further data from other key individuals, teams and clubs will shed further light on: (a) the present findings, and (b) assist refine strategies that are likely to be effective in working with not only coaches, but others surrounding a variety of situational-contexts to support LLIP.

2. Exploring and understanding factors associated with LLIP behaviours, such as SET, with a larger sample of coaches is warranted to ensure intervention efforts are enhanced and effective as possible. From a public health perspective, there are approximately 650,000 coaches registered in Australia [495] and it would be of benefit for future studies to examine coaches

(at various levels) from a variety of sports to obtain a cross-section of information which could be more applicable to the population of coaches and specific situational contexts whereby different sports (including AF) is played. This could also help identify if SET programs have been diffused to any extent among the AF coaching community, for example, and how this may have occurred (e.g., coaches' social networks and communication, coaches' communities of practice).

3. While it is important to apply theories to predict behaviour, it is also essential to foster behaviour change. Future research could focus on adapting this theory-based research from theory to practice, for instance using the SCT and TTM to design behavioural modification interventions into SET programs, coaching practices and developmental pathways.

4. *Longitudinal studies.* Longitudinal studies seem warranted, whereby multiple interviews and/or questionnaires are conducted with coaches at different stages (e.g., coinciding with exercise progression stages) throughout the implementation of SET to provide an accurate or more in-depth representation of SET and its impact on LLI outcomes. This suggested approach might also include stimulated recall sessions, where coaches are shown footage of coaching behaviours and asked to explain why they would behave as they do during specific times. This would provide more detailed information regarding the nuances of coaching and enhancing the effective of SET program implementation and maintenance at the community level. For example, information relating to managing team dynamics, interpersonal relationships and how the coach attends to team and individual needs could be garnered. Focus group discussions could also be conducted with players as part of team meetings throughout the beginning of the season, competition session and post competition periods, or replicate approaches as discussed above with coaches. Studies utilising a more long term ethnographic, action research or multi-case study approach might be considered for the above purposes. These approaches would enable coaches and players to describe the implementation and maintenance of SET as it unfolds.

5. *Extension and development of a more comprehensive robust questionnaire tool.* Given this thesis research was largely exploratory and descriptive, the questionnaire tools used in this research could be further developed and refined to add help in better understanding factors that may enhance or hinder the adoption and maintenance of SET to prevent LLIs. A more developed survey could then subsequently be used with larger samples of coaches across Australia and multiple sports. Such a tool (or modified version), as an example, could also function as an assessment tool for consultants (e.g., sport psychologists or strength and conditioning coaches) providing services to coaches (whether direct or indirect) [759,761,764,839] to: (1) identify pertinent team dynamic and injury issues, (2) assess readiness of a coach or their team to adopt and maintain SET, (3) suggest areas for preparatory training/education for SET, and (4) customise the SET program approach for each club.

6. *Observational studies.* The importance of observational methods in coaching, and sport and exercise psychology research has been central in the study of coach behaviour and recognised for some time [421,755,840,841]. However, as indicated in Chapter 4, observational studies have been largely ignored in coach-injury prevention research, with the exception of a few studies. As such, the ability to fully comprehend the intricacies of coaching and the implementation of safety programs, and most effectively promote coach development in sport safety (e.g., SET) through coach education remains limited. Based on the findings of the coach review (see Chapter 4), systematic and direct observation studies are recommended as a key methodology for investigating behavioural indicators for future research directions in sport injury prevention. In light of the research findings in Chapters 8-13, it is likely that observational methods can capture inaccessible levels of complexity associated with behavioural determinants, than by self-report alone. For example, in Chapter 12, a coach alluded to the SET trainer's lack of reinforcement and feedback towards players undertaking exercises. Using observational methods may have been a way to deepen understanding of such

behavioural relationships and their variability (e.g., interpersonal processes such as reciprocal coach-athlete interactions). Without such investigation it may be that key determinants to both coaches' and athletes' behaviour and outcomes (e.g., adherence to SET) are not identified, and valuable process detail is being ignored that could better inform coach education on the practical implementation of training session (behaviour) content findings. Contributions and recommendations from coach observational research, including use of tools such as Coaching Behaviour Assessment System (CBAS) [586], Coach-Athlete Interaction Coding System (CAICS) [589] software developed [842], and methodology using interactive systems framework, state space grids [589,843,844], and video based performance analysis [590,634,845-847] should be considered, adapted and applied to sport injury prevention research in conjunction with mixed approaches. Taking such an approach is likely to have an impact on understanding the nature of the coaching process, the preventive behaviours coaches use, and the relationship between these preventive behaviours and their antecedents and various athlete outcomes (e.g., injury susceptibility).

7. *Conceptual model.* Based on the findings in this thesis associated with coaches' salient beliefs and other empirical work (e.g., models/concepts) a new integrative conceptual model of coaches' behaviour change for incorporating and maintaining SET into their training practices/CAF settings could be developed. This would aim to provide a holistic account of the mechanisms or processes that underlie the objectives of this thesis, and potentially guide further research and/or applied practice. Given that this is the first time this model is being proposed, comprehensive tests of the model will be needed of it in future research. Such testing would provide further support for the proposed factors and network of relations derived from the multiple theories and models (i.e., known as nominal validity). Additionally, once the conceptual model is more fully developed, a working group compromising of coaches, researchers and applied practitioners could be used to assess the feasibility of the model in

applied practice further. Validation of conceptual models through expert consensus has been shown to be an effective approach [482] and additional empirical work can be used to support the model as it evolves over time.

8. *Taxonomy of behaviour change strategies and techniques.* A taxonomy of behaviour change strategies or techniques applicable to findings could be developed to promote uptake and optimal use of SET to reduce the risks of LLIs and increase participation in CAF. The process of designing behaviour change interventions is complex, and learning from other research evidence for characterising and designing behaviour change methods would seem warranted [273,401,500,500,501,836,838,848-851]. The techniques devised can then be used by researchers to test the efficacy of techniques to support adoption or maintenance of SET. Practitioners and coaches can also use the taxonomy of techniques as content in interventions to promote safety-related behaviour, such as SET, delivered by various means such as print communication (e.g., leaflets, wallets), mobile applications, media campaigns (e.g., posters, radio, advertisements), and personal communication (e.g., by sport psychologist or strength and conditioning coaches). The preliminary conceptual model of behaviour change for sport injury prevention outlined previously in this section is expected to form the basis of further development of this taxonomy (in additional to theoretically implied applications) and provide a comprehensive, evidence-based guide for interventions by identifying the key factors that impact on coaches incorporating and maintaining SET in their training.

9. *Reviews of literature*. Further comprehensive reviews (and/or meta-analysis) are likely to be needed in the future (e.g., next 5-10 years) to extend existing reviews completed in this thesis research (Chapters 2-4). The systematic review process can provide a structured approach for evaluating the literature and synthesizing evidence regarding prevention strategies in sport contexts. Furthermore, undertaking additional systematic reviews provides an opportunity to critically reflect on the accumulation of research, methods used, and identify fruitful directions

for best practice and research. For example, synthesising research on the effect of various theoretical factors and their relevant antecedent factors on salient sport and exercise injury prevention behaviours (e.g., SET adoption and maintenance behaviours to prevent LLIs) would appear important. This would provide insights into the nature, extent and robustness of different factors on the salient behavioural outcomes of a variety of safety behaviours in sport. Therefore, while some important factors have been identified in this research, and existing research indicating the importance of various factors to effective safety behaviour implementation, additional analyses of literature would provide support of these initial findings as the relevant implementation research builds momentum and the field grows. In conducting further reviews it also augments the challenge to provide consistent and up-to-date evidence-based information to researchers, coaches and others in the sporting area.

10. Finally, future research could be undertaken on other coach populations, female coaches, or coaches who coach female AF teams. It is possible that female coaches face different challenges to male coaches, and coaching female teams versus male teams often requires differing approaches. Given that females in general have been shown to experience more LLIs in team sports [93,805,834,835], incorporating SET into their training and investigating coaching and other dynamics would seem a worthwhile endeavour. From a public health perspective, it is also relevant to explore coaches in other popular at-risk sports, age groups (children, adolescents and adults), performance levels, cultural backgrounds, and different countries.

14.5 Final Comments

In conclusion, this thesis has extended theory application and real-world applicability in assessing and determining mechanisms and processes in which can be developed to enhance the effectiveness of adoption and maintenance of SET to prevent LLIs. Future research arising from this thesis has the potential to provide a greater detail of insight into the most effective means of how to work with coaches and others in AF environments, as well as provide some guidance for the area of sport injury prevention with regard to promotion of the field to the public.

Although definitive conclusions cannot be provided around the overall effectiveness of coach tailored interventions (e.g., education), there is no evidence to suggest that such interventions may be harmful. Researchers should focus on attempts to create theoretically grounded coach education interventions, relevant to the focus of this thesis research and indeed incorporate these in holistic and multilevel ecological system interventions, targeting players, club administrators, medical personnel, strength and conditioning experts, sport psychologist and AFL bodies and educators/mentors. Understanding more about coach education interventions (and other behaviour change interventions) can assist both researchers and practitioners to develop a range of strategies that target coaches' intra- and inter-personal effectiveness and consequently impact on their players' behaviour, affect and cognition.

With the increases in sport participation, and consequently the increase in the number of sporting injuries, it is crucial to the ultimate goal of safe and sustainable participation in AF that players are prepared both physically and mentally to prevent (or reduce the chances of) a high proportion of LLIs occurring. Coaches' preparation and development are key to this crucial goal, as indicative by the findings in this research which can now be studied and evaluated in greater depth in the future.

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Appendix A: Human Research Ethics Approval Forms

Human Research Ethics Committee (HREC)

Research & Graduate Studies Office

HUMAN RESEARCH ETHICS APPROVAL FORM

Principal Researcher/Supervisor: C Finch / D Lloyd / B Elliot

Associate/Student Researcher/s: J Orchard / D Twomey / T Doyle
S Ullah / A McGlashan

School: Human Movement & Sport Sciences

Ethics Approval has been granted for the following project:

Project Number: B06-029

Project Title: A randomised controlled trial of exercise training programs for preventing knee injuries

For the period: 9/5/2006 **to** 31/12/2009

Please quote the Project No. in all correspondence regarding this application.

PLEASE NOTE:

Annual reports for this project must be submitted to the HREC Executive Officer on:
9 May 2007
9 May 2008
9 May 2009

A final report for this project must be submitted to the HREC Executive Officer on:
31 January 2010

Laura Quinlan

Ethics Officer
13 August 2009

If any changes are to be made to this project, a 'Request for Amendments' form must be completed and forwarded to the Ethics Officer for approval.

Human Research Ethics Committee

APPROVAL

Principal Researcher:	C Finch
Associate/Student Researcher/s:	A McGlashan S Wellard D Twomey
School/Section:	HMSS
Project Number:	B09-083
Project Title:	Factors influencing the uptake and maintenance of exercise training programs for preventing lower limb injuries
For the period:	28/5/2009 **to** 7/5/2010

Please quote the Project No. in all correspondence regarding this application.

REPORTS TO HREC:

A final report for this project must be submitted to the Ethics Officer on:
7 June 2010
www.ballarat.edu.au/ard/ubresearch/hdrs/ethics/humanethics/docs/final_report.doc

Laura Quinlan

Ethics Officer
28 May 2009

If any changes are to be made to this project, a 'Request for Amendments' form must be completed and forwarded to the Ethics Officer for approval.

Appendix B: PAFIX Program Manuals

Training Program #1

Exercise Instruction Manual

THE UNIVERSITY OF WESTERN AUSTRALIA

PREVENTING AUSTRALIAN FOOTBALL INJURIES THROUGH EXERCISE

PREVENTING AUSTRALIAN FOOTBALL INJURIES THROUGH EXERCISE

This project is funded by the National Health and Medical Council (NHMRC) and proudly supported by Football Victoria and the Western Australian Football Commission.

Table of Contents

Abbreviations:

SLS = Single leg stance

DLS = Double leg stance

DL = Double leg

SL = Single leg

EO = Eyes open

EC = Eyes closed

HB = Head back

COD = Change of direction

PP = Pre-planned

UP = Un-planned

Conventions

Jump = Two legged movement

Hop = One legged ipsi-lateral i.e., left leg to left leg

Bound = One legged contra-lateral i.e., left leg to right leg

Asterisks beside exercises indicate these exercise can be run concurrently.
Some programs have 1 or 2 asterisks, in this case only run exercises concurrently with the same number of asterisks.

Basic Movement Exercises

Squares (10 m)

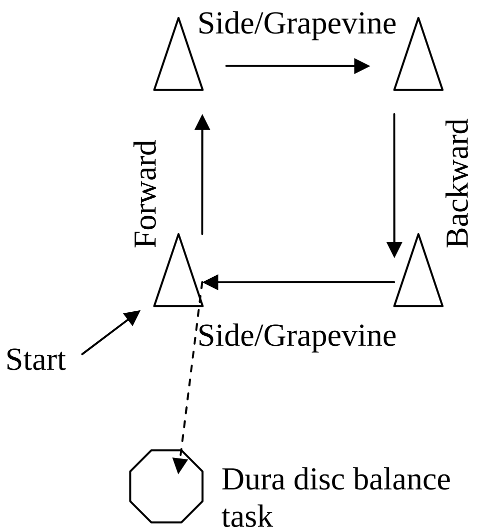
Players run as indicated in diagram

After completing the running component they complete a balance task that can be modified to match skill as necessary

i.e., DLS (HB) 20 sec

Equipment

- Cones
- Dura discs



Key points

- Smooth transition between running tasks
- Maintain balance on balance task

Weaving Bounds (a)

Cones are placed 1 m apart in the direction of movement

Length of cones is about 10 metres

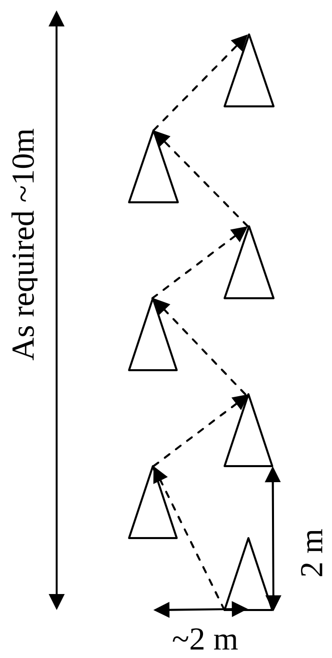
Channel through which players bound is about 2 m wide

Players are to bound weaving from cone to cone

Bounding speed is moderate pace

Equipment

- Cones



Key points

- Smooth transition between bounds
- Maintain stable upper body i.e., no leaning

Weaving Bounds (b)

Cones are placed 1 m apart in the direction of movement

Length of cones is about 10 metres

Channel through which players bound is larger than previous exercise, > 2 m

Players are to bound weaving aggressively from cone to cone

Bounding speed is moderate to fast pace

Players are provided with instruction as to how best to weave

i.e., body upright, no twisting, keeping foot close to mid-line

Equipment

- Cones

  See previous diagram. Adjust distances as needed.

Key points

- Sharp/hard bounds from cone to cone
- Smooth transition between bounds
- Maintain stable upper body i.e., no leaning

Weaving Hops

Cones are placed < 1 m apart in the direction of movement

Length of cones is 10 metres

Channel through which players run is narrower than previous exercise, ~ 1 m

Players are to hop on same leg from cone to cone

Players are provided with instruction as to how best to weave

i.e., body upright, no twisting, keeping foot close to mid-line

Equipment

- Cones

See previous diagram. Adjust distances as needed.

Key points

- Smooth transition between hops
- Maintain stable upper body i.e., no leaning
- Maintain lower leg stability i.e., no wavering of knee

Balance Exercises

Dura-Disc Balance

Players are to maintain balance on dura disc for specified amount of time.

Variations to this exercise include

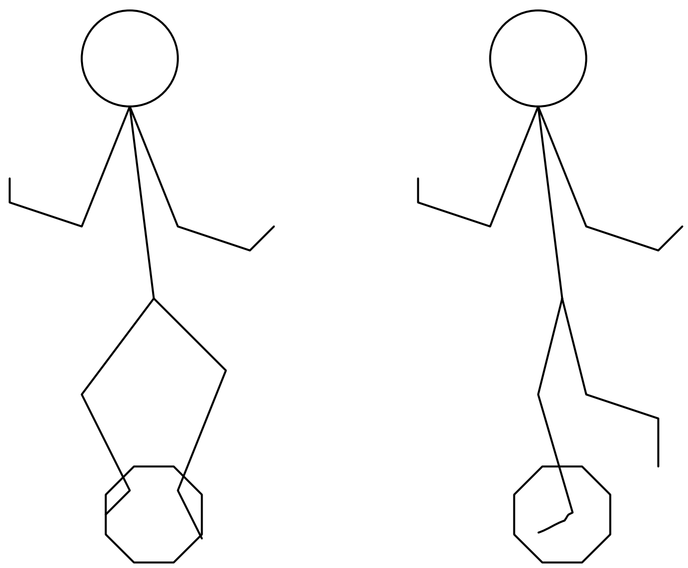
DLS/SLS

EO/EC

HB

Equipment

- Dura disc



Key points

- Must concentrate to complete required time
- Maintain balance with as little movement of arms/legs as possible

Wobble Board Balance

Players to maintain balance on a wobble board for specified amount of time.

Variations to this exercise include

Double leg stance (DLS)

Single leg stance (SLS)

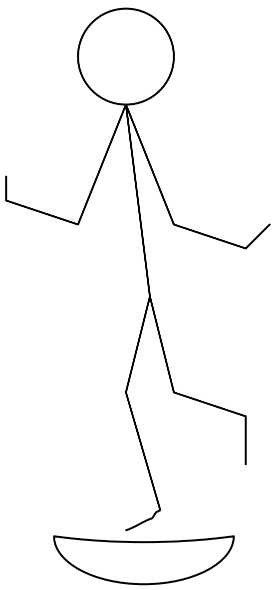
Eyes Open (EO)

Eyes Closed (EC)

Head back (HB)

Equipment

- Wobble board



<u>Progressions</u>

Tasks can be made more difficult by including movements of arms, legs, etc. as players improve. For hand passing drills target outside of body, and touch further away. Increase speed of movements.

Key points

- Must concentrate to complete required time
- Maintain balance with as little movement of arms/legs as possible

Balance Hand Passing

Conducted in pairs, players hand pass to each other over a distance of 10 meters for a specified amount of time

Variations of this drill include

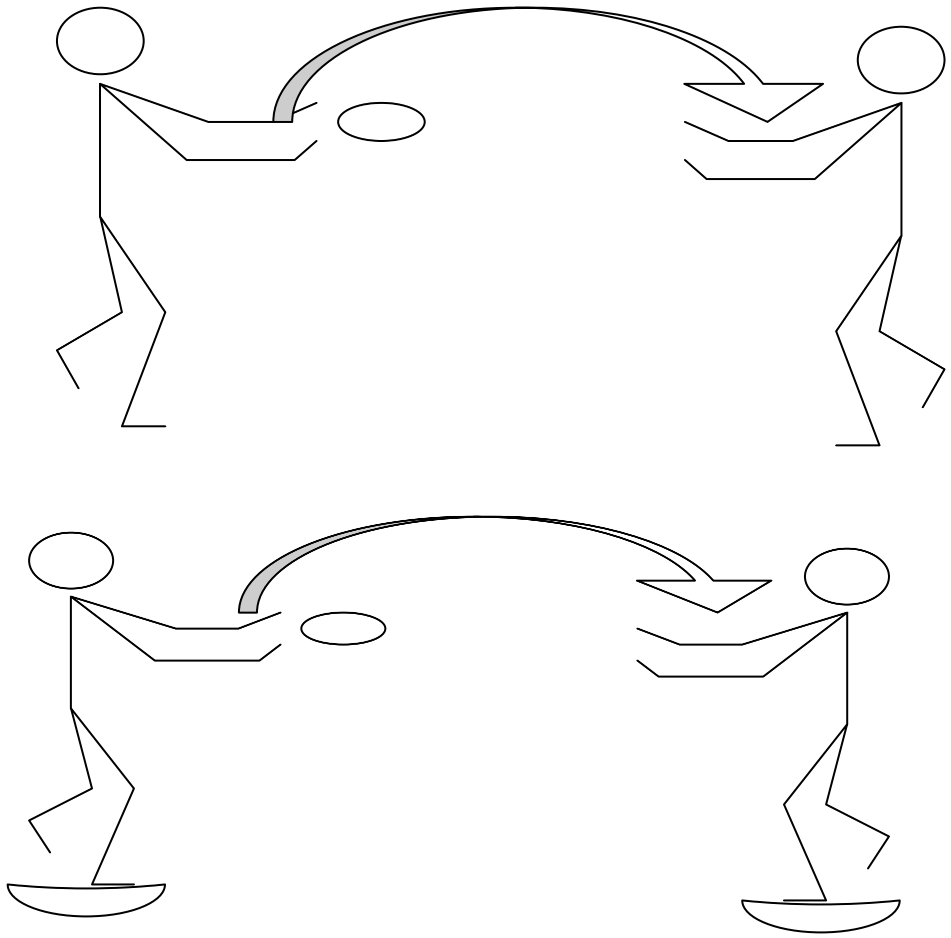
touching the ball to the ground in between passes

standing on a wobble board/dura disc

SLS/DLS

Equipment

- Footballs
- Wobble board



Key points

- Focus on maintaining balance and not pass
- Must maintain balance with as little extraneous movement of arms/legs as possible

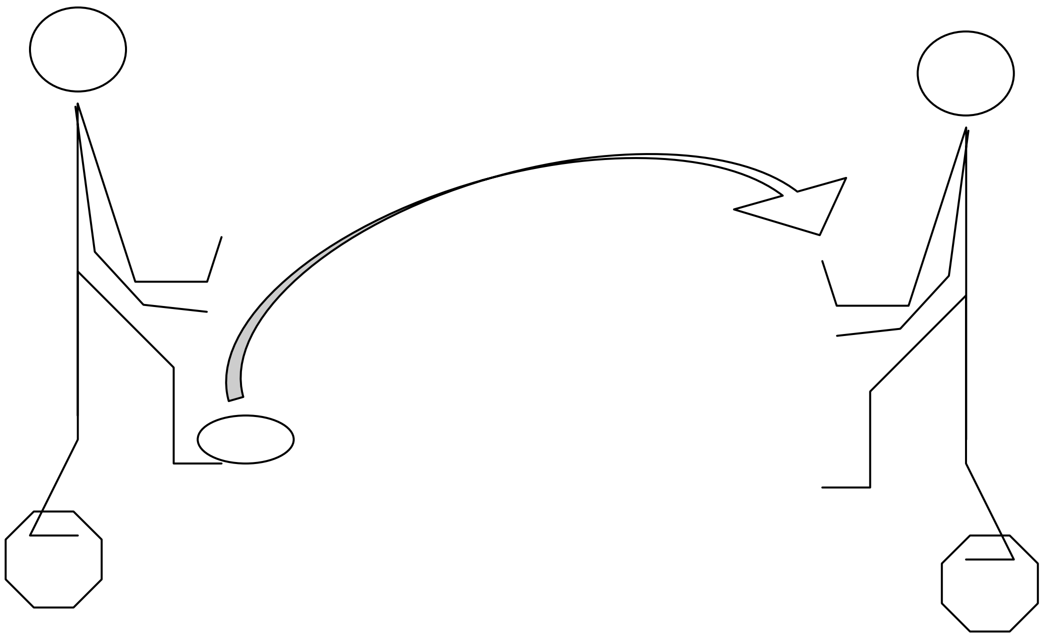
Balance Kicking

Conducted in pairs, players kick to each other over a distance of 10 meters for a specified amount of time

Usually conducted as SLS but can vary with DLS as skill dictates

Equipment

- Footballs
- Dura disc



Key points

- Focus on maintaining balance and not kick
- Must maintain balance with as little extraneous movement of arms/legs as possible

Hopping Exercises

Dura-Disc Hop

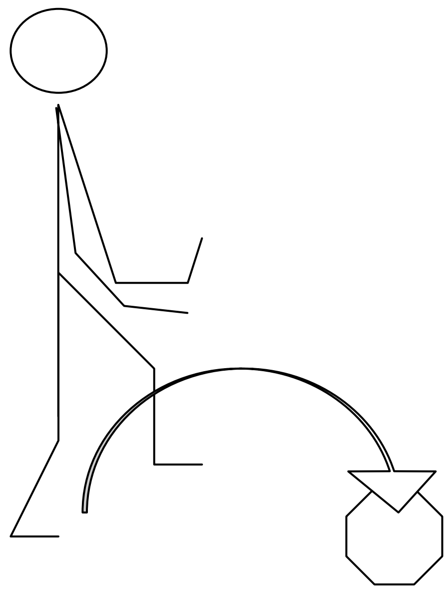
Hop onto dura disc hold SLS balance for period of time

Can vary balance after hop as per usual Dura Disc Balance

Time to hold balance on dura disc may be specified

Equipment

- Dura disc



Key points

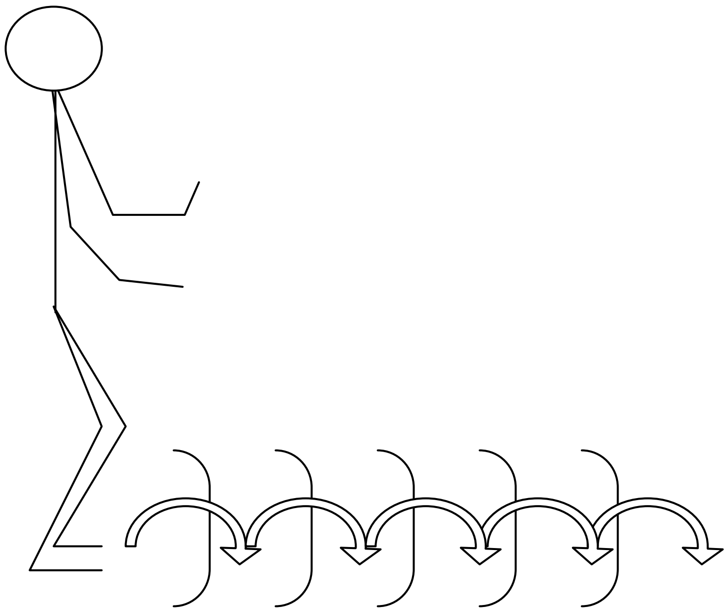
- Must maintain balance after hop
- Keep extraneous arm and leg movement to a minimum

Hurdle Jumps

Continuous jumping over hurdles

Equipment

- Hurdles



Key points

- Smooth transition between jumps
- Flex knees to absorb landing
- Maintain lower leg stability i.e., no wavering of knee

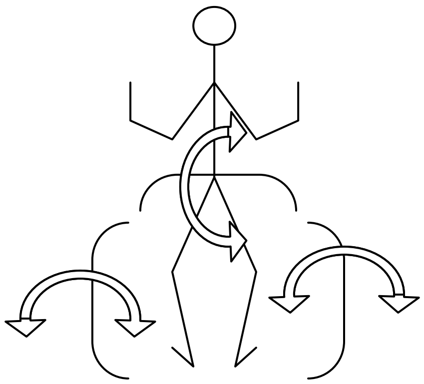
Lateral Hurdle Jumps

Players jump forward/backward over hurdles then side/side (left) and side/side (right)

Instruction is provided regarding technique as usual

Equipment

- Hurdles



Key points

- Flex knees to absorb landing
- Keep extraneous arm and upper body movement to a minimum
- Maintain lower leg stability i.e., no wavering of knee

Hurdle Jump (PP Step)

Players jump forward over hurdle then immediately perform a step to left or right

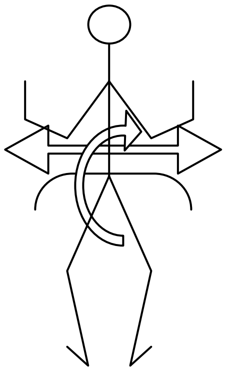
Knowledge about step direction is given prior to task

Instruction is provided regarding technique as usual

Player can run with ball in hand

Equipment

- Hurdles
- Football



Key points

- Flex knees to absorb landing
- Keep foot close to hips

Hurdle Jump (UP Step)

Players jump forward over hurdle then immediately perform a step to left or right

Knowledge about step direction is *not given* prior to task

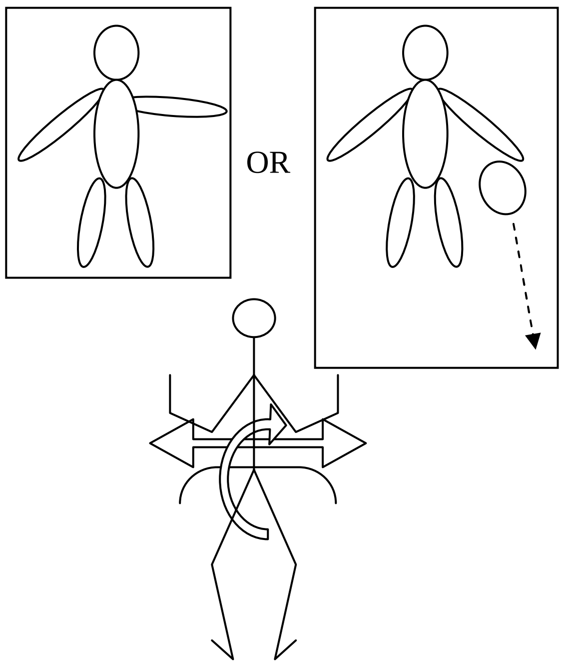
Stimulus is handball to side or,

Stimulus is trainer/player pointing

Instruction is provided regarding technique as usual

Equipment

- Hurdles
- Football



Key points

- Smooth transition from hop to step
- Avoid excessive upper body movement
- Keep foot close to hips

Hurdle Hop

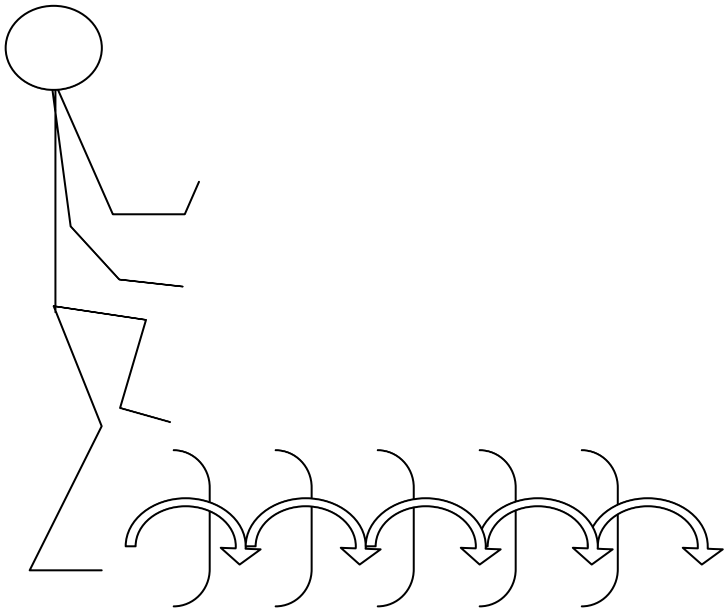
On a single leg players hop continuously forward over hurdles

Number of hurdles is pre-determined (about 5)

Players alternate legs with each set

Equipment

- Hurdles



Key points

- Avoid excessive upper body movement
- Maintain lower leg stability i.e., no wavering of knee
- Flex knees to absorb landing

Change of Direction Exercises

PP COD

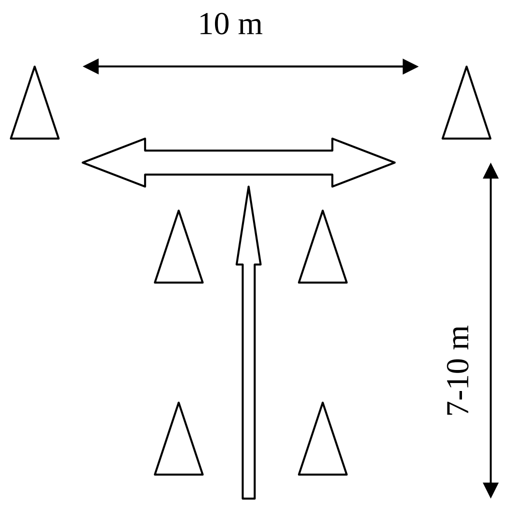
With prior knowledge of which way to cut players run up the middle and cut left or right

Players are provided with instruction with respect to their COD technique

Players are to run with a ball in their hands

Equipment

- Cones
- Footballs



Key points

- Avoid excessive upper body movement i.e., no leaning
- Keep arms close to body
- Keep foot close to hips

UP COD

Without prior knowledge of which way to cut players run up the middle and are directed by a stimulus which way to cut

Stimulus is handball to side or,

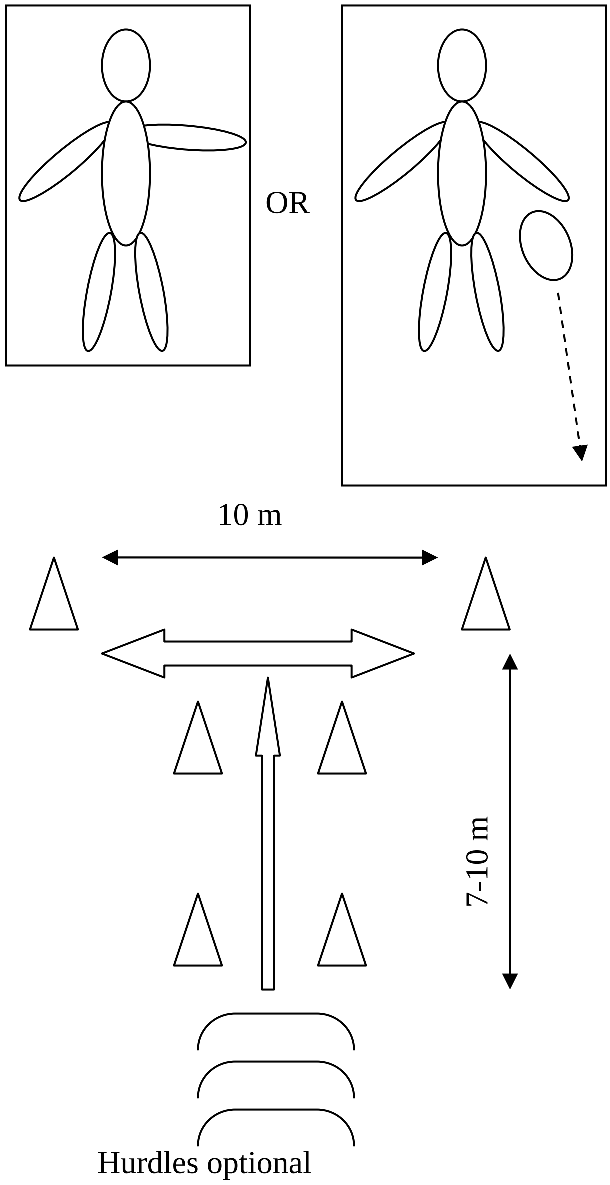
Stimulus is trainer/player pointing (run with ball in hand)

Players are provided with instruction with respect to their COD technique

The task can be made more difficult by placing hurdles at start of task

Equipment

- Cones
- Footballs
- Hurdles



Key points

- Avoid excessive upper body movement i.e., no leaning
- Keep arms close to body
- Keep foot close to hips

UP COD (180 Turn)

Without prior knowledge of which way to cut players run up the middle and are directed by a stimulus which way to cut

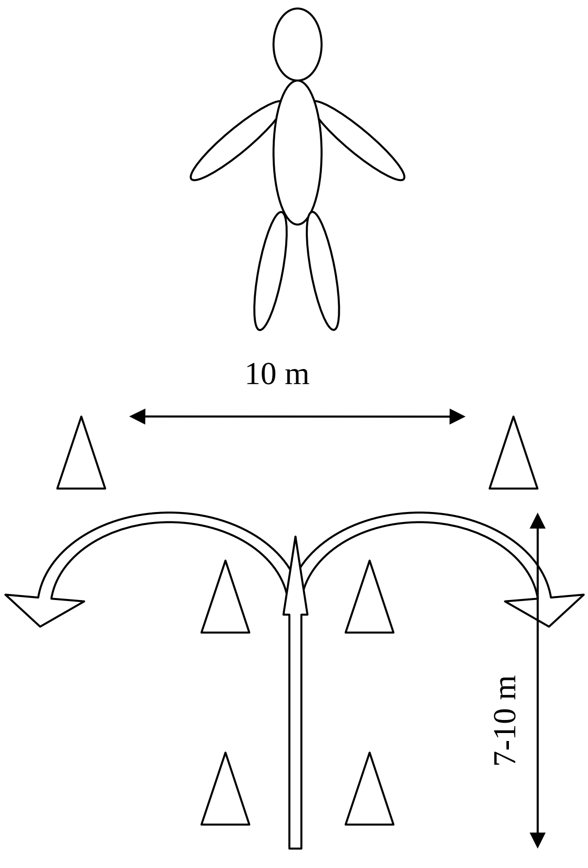
Stimulus is defensive player that must be avoided (run with ball in hand)

After making cut players make a 180 turn back to start as quickly as possible

Players are provided with instruction with respect to their COD technique

Equipment

- Cones
- Footballs



Key points

- Avoid excessive upper body movement i.e., no leaning
- Keep arms close to body
- Bend knees for turning

Swiss Ball Exercises

SB Kneeling

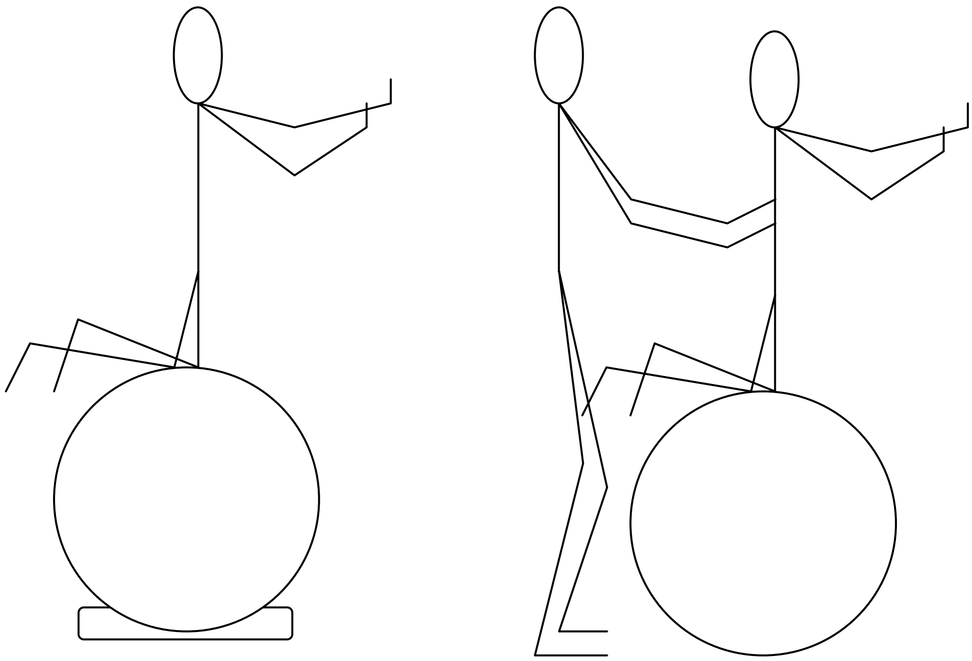
Using a base for the Swiss ball players are to balance on ball for specified period of time

Variations include

No base, but partner to assist when needed

Equipment

- Swiss ball
- Support base



Key points

- Concentrate to complete task
- Avoid excessive arm movement
- Avoid excessive trunk movement

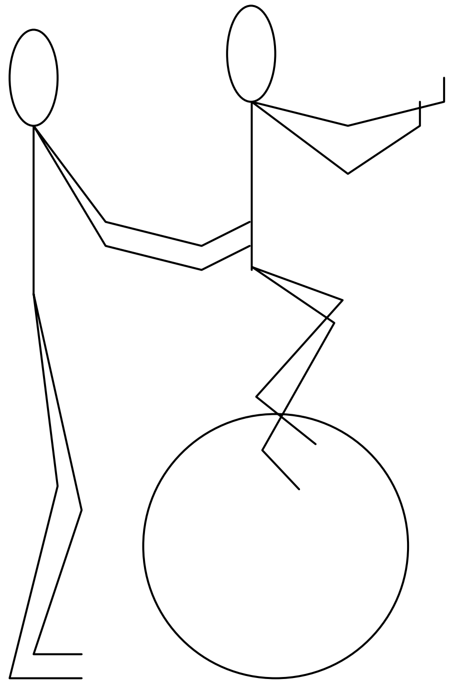
SB Squat

Players are to balance in a semi-squat on ball for specified period of time

A partner can assist when needed

Equipment

- Swiss ball



Key points

- Concentrate to complete task
- Avoid excessive arm movement
- Avoid excessive trunk movement

Mini-tramp Exercises

Mini-Tramp Land

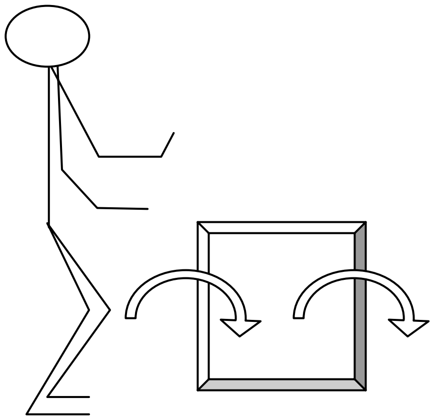
Players are to jump or hop onto the min-tramp and land with good technique

Instruction is provided regarding technique as usual

Can be performed as a DL or SL drill

Equipment

- Mini-tramp
- Footballs



Progressions

Tasks can be made more difficult by including movements of arms, legs, etc. as players improve. For hand passing drills target outside of body, and touch further away. Increase speed of movements. DL movements *may* progress to SL. Mini-tramp can increase lateral distance of jump.

Key points

- Bend knees to absorb landing
- Avoid excessive trunk movement
- Keep arms close to body

Mini-Tramp Land (Lateral Hop)

Players are to jump or hop onto the min-tramp and land

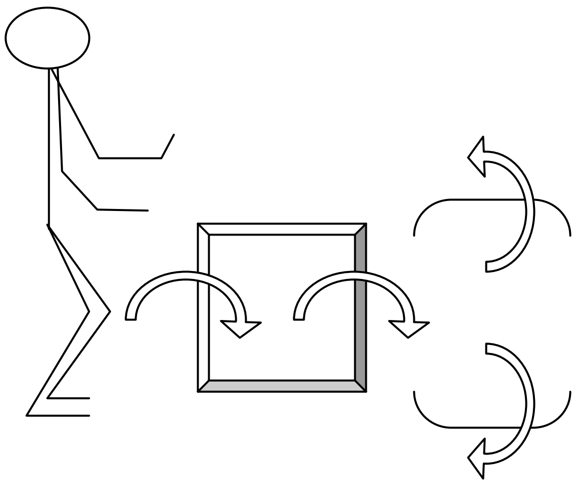
Immediately after landing they are to laterally hop to left or right as per *prior* instruction

Drill is conducted with ball in hand

Instruction is provided regarding technique as usual

Equipment

- Mini-tramp
- Footballs
- Hurdles



Key points

- Bend knees to absorb landing
- Don't lean upper body
- Stop excessive forward motion

Mini-Tramp Land (Hop, Step)

Players are to jump onto the min-tramp and land

Immediately after landing they are to hop forward and then step left or right as per stimulus

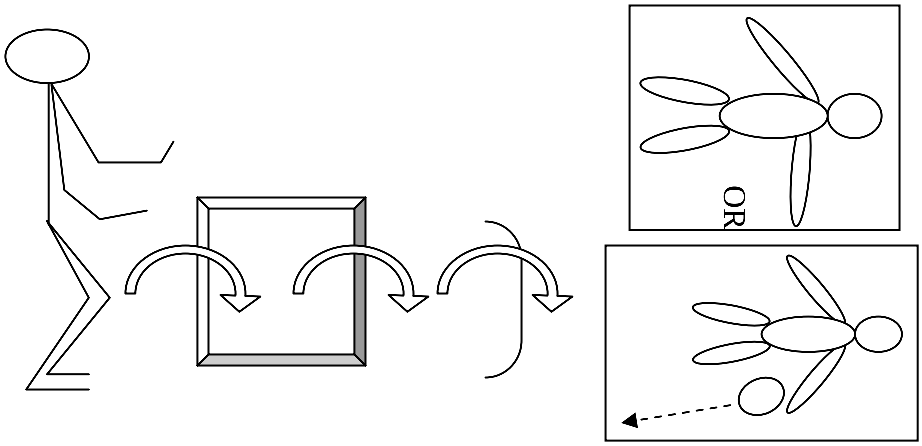
Stimulus is handball to side or,

Stimulus is trainer/player pointing (run with ball in hand)

Instruction is provided regarding technique as usual

Equipment

- Mini-tramp
- Footballs
- Hurdles



Key points

- Bend knees to absorb landing
- Keep arms close to body
- Keep foot close to hips

Mini-Tramp Land (Catch, Step)

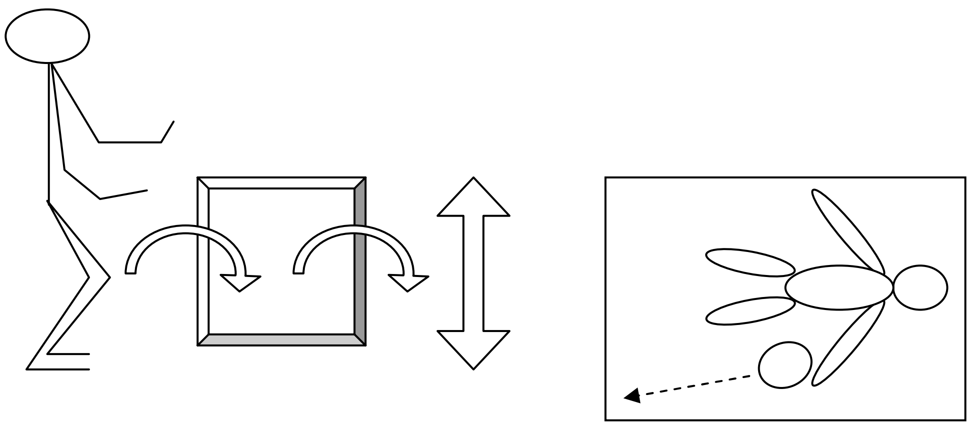
Players are to jump/hop onto the min-tramp and land

As they are landing a ball will be hand passed indicating direction to cut

Instruction is provided regarding technique as usual

Equipment

- Mini-tramp
- Footballs



Key points

- Bend knees to absorb landing
- Keep arms close to body
- Keep foot close to hips

Training Exercises Rollout

Tim Doyle
Season 2007

Training Week		1–4	5–8	9–13	14–18	19–23	24–28	29–32
Season Dates (Based on 2006)								
Focus		Gen. Prep.	Basic/Aggress.	Aggressive 1	Aggressive 2	Maintenance 1	Maintenance 2	Maintenance 3
Intensity								
Frequency		2 per week	2 per week	2 per week	2 per week	1 per week	1 per week	1 per week
BALANCE	DURA-DISC BALANCE (DLS)							
	DURA-DISC BALANCE (SLS)							
	WOBBLE BOARD (SLS/DLS)							
	SWISS BALL KNEELING (ON BASE)							
	SWISS BALL KNEELING (NO BASE W/WO PART.)							
	SWISS BALL SQUAT							
BALANCE W/-TASK	BALANCE HANDPASSING (W/WO TOUCH GROUND)							
	BALANCE KICKING DURA-DISC							
	BALANCE HAND PASSING DURA-DISC							
	HOP - DURA-DISC BALANCE							
	BALANCE HANDPASSING (WOBBLE)							
BASIC M'MENT TASK	10 METRE SQUARES (MULTI-DIRECTN RUN)							
	WEAVING BOUNDS							
	WEAVING HOPS							
COD TASKS (SIDE-STEPPING)	PRE-PLANNED							
	UN-PLANNED POINTING							
	UN-PLANNED PLAYER							
	UN-PLANNED BALL							
LANDING TASKS	HURDLE JUMPS							
	LATERAL HURDLE JUMPS							
	MINI-TRAMP LAND							
	HOP							
	JUMPS (UP/PP)							
	MINI-TRAMP LANDING SL/DL PP HOP/JUMP (HURDLE)							
	MINI-TRAMP LAND (HOP, STEP)							
	MINI-TRAMP LAND (CATCH , STEP)							
STEPPING TASKS	MINI-TRAMP LAND (LATERAL HOP)							

Training Program #2

Exercise Instruction Manual

University of Ballarat Australia

The University of Western Australia

PAFIX

Preventing Australian Football Injuries Through Exercise

This project is funded by the National Health and Medical Council (NHMRC) and proudly supported by Football Victoria and the Western Australian Football Commission.

Table of Contents

Abbreviations:

SLS = Single leg stance

DLS = Double leg stance

DL = Double leg

SL = Single leg

EO = Eyes open

EC = Eyes closed

HB = Head back

COD = Change of direction

PP = Pre-planned

UP = Un-planned

Conventions

Jump = Two legged movement

Hop = One legged ipsi-lateral i.e., left leg to left leg

Bound = One legged contra-lateral i.e., left leg to right leg

Asterisks beside exercises indicate these exercise can be run concurrently.
Some programs have 1 or 2 asterisks, in this case only run exercises concurrently with the same number of asterisks.

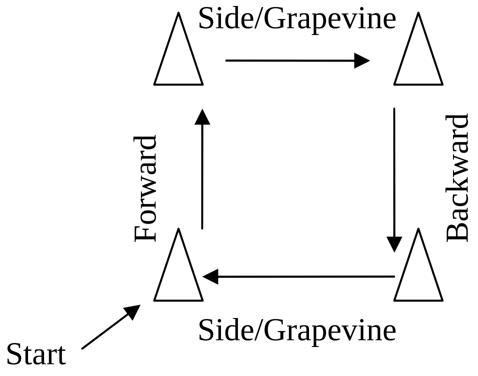
Basic Movement Exercises

Squares (10 m)

Players run as indicated in diagram

Equipment

- Cones
- Dura discs



Key point

- Smooth transition between running tasks

Weaving Bounds (a)

Cones are placed 1 m apart in the direction of movement

Channel through which players bound is about 2 m wide

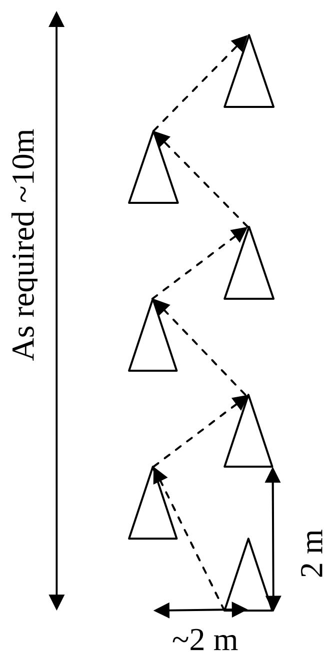
Length of cones is about 10 metres

Players are to bound weaving from cone to cone

Bounding speed is moderate pace

Equipment

- Cones



Key point

- Emphasise forward running speed

Weaving Bounds (b)

Cones are placed 1 m apart in the direction of movement

Length of cones is about 10 metres

Channel through which players bound is larger than previous exercise, > 2 m

Bounding speed is moderate to fast pace

Equipment

- Cones

See previous diagram. Adjust distances as needed.

Key point

- Emphasise forward running speed

Shuttle Runs

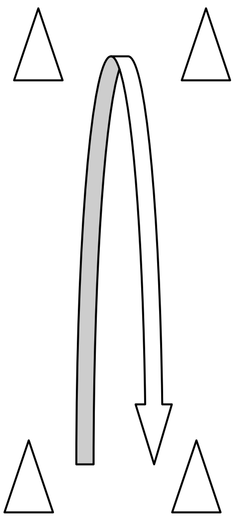
Cones are placed in a square outlining a 20 m distance

1 rep is up and back

Players run up and back for required number of reps at moderate-fast pace

Equipment

- Cones



Key point

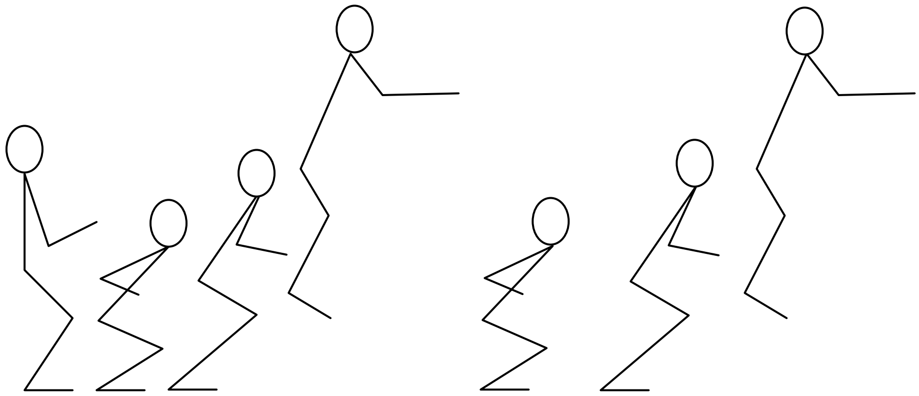
- Quick turnaround at top

Bunny Jumps

Using a powerful arm swing to help propel forward players jump forward for required number of jumps

Equipment

- N/A



Key point

- Quick transition between jumps

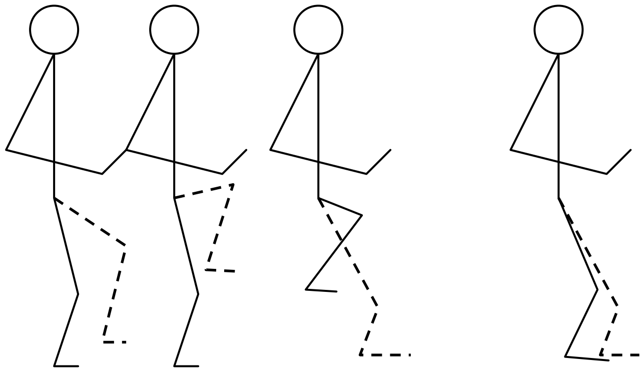
Standing Triples

Players perform a hop, skip, and jump from a standing start

Players should try to jump further with each rep

Equipment

- N/A



Key point

- Quick transition between each rep

General Sprinting Exercises

Sprints (Lying Start)

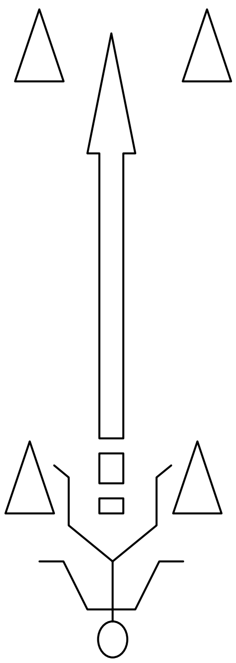
Players start lying on their stomach with feet pointing in direction to run

On command players get up as quick as possible and run over required distance

Walk back to start for recovery

Equipment

- Cones



Key point

- Quick transition from lying to standing

Resisted Sprints (5+15m)

Player behind the sprinter grabs their waist

The sprinter is resisted for the first 5 m and is to emphasise leg drive and stride rate

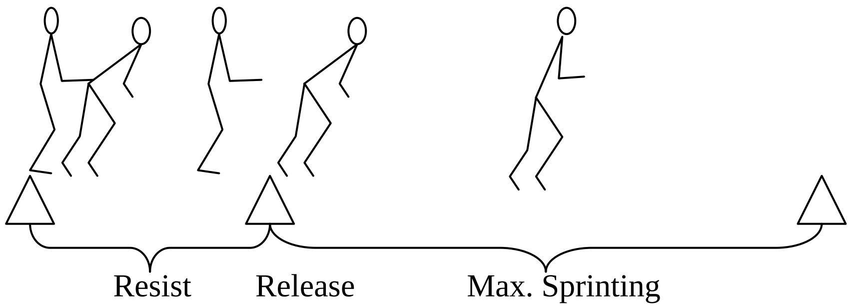
Both are to move forward to the 5 m mark

At the 5 m mark the sprinter is realised and sprints maximally for 15 m

Sprinter is to run with ball in hand

Equipment

- Cones
- Footballs



Key point

- Emphasise forward body lean and short, quick strides

Tempo Runs

Exercise is performed over a total distance of 40 m

The first 10 m requires players to perform one of a number of drills

Ankling

Walking/Skipping A's

Stiff leg pull throughs

Grapevine

Side-to-side

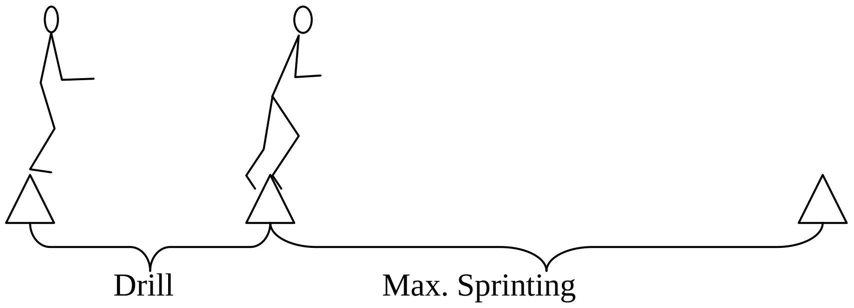
These drills are to be varied by trainer as required

After the drill players accelerate and sprint the last 30 m as fast as possible

Maintain good sprinting technique

Equipment

- Cones



Key point

- Emphasis on the drill at the start

Acceleration/Deceleration Exercises

Kneeling Beach Sprints

One on knee

Rear foot must be flat

Push off front foot going up and forward

Trailing foot/leg must be strong to support weight on 1st step

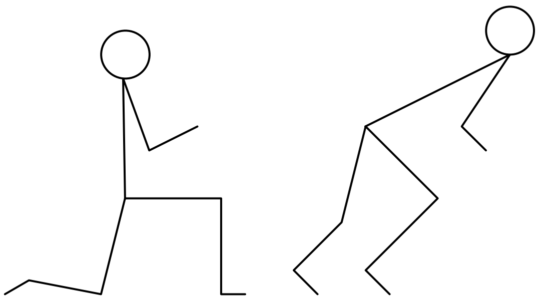
Maintain sprinting technique

Handicap players if necessary (i.e., faster ones start behind)

Look for good lean at start

Equipment

- N/A



Key point

- Quick transition from one knee to up

Graduated Sprints (20m)

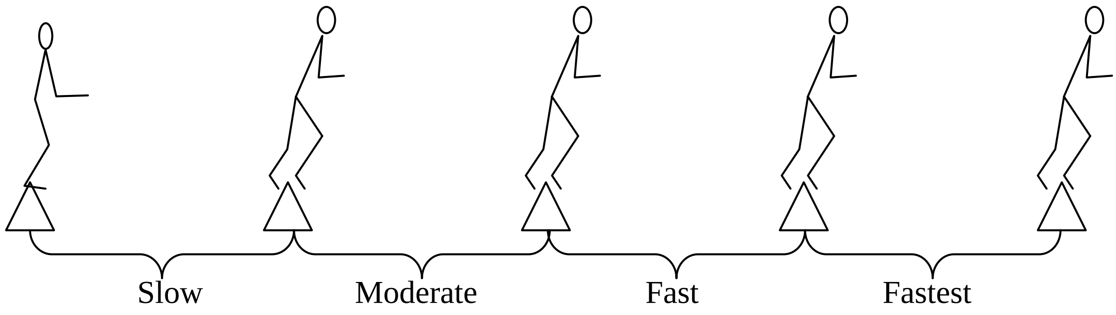
Players run and accelerate at each check point

Emphasise a sudden change in speed at 5, 10, 15 m

At 15 m players should be running maximally

Equipment

- Cones



Key point

- Emphasise sudden speed changes at each marker

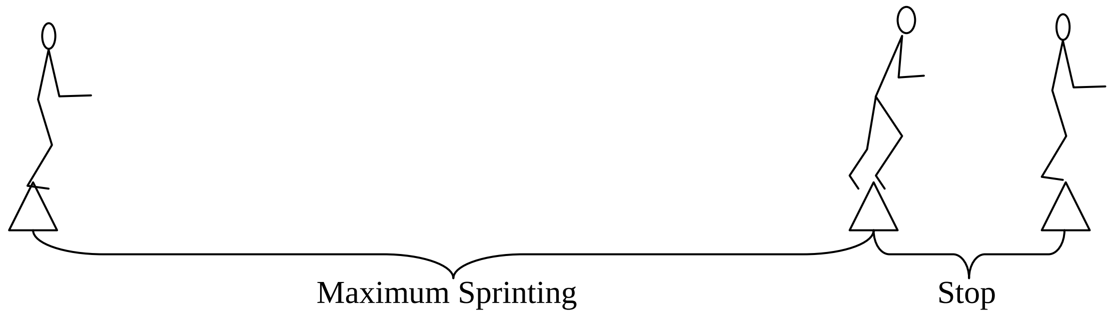
Stoppies (10+2m)

Players run as fast as they can for 10 m

They must come to a complete stop within 2 m after the 10 m

Equipment

- Cones



Key point

- Must stop abruptly in 2 metre

COD/Agility Exercises

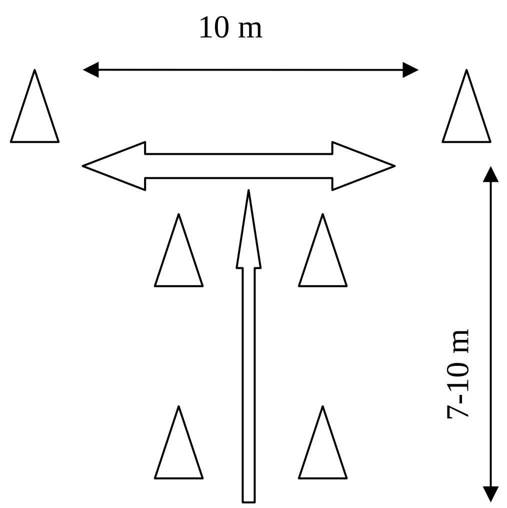
PP COD

With prior knowledge of which way to cut players run up the middle and cut left or right

Players are to run with a ball in their hands

Equipment

- Cones
- Footballs



Key point

- Complete task as fast as possible

UP COD (180 Turn)

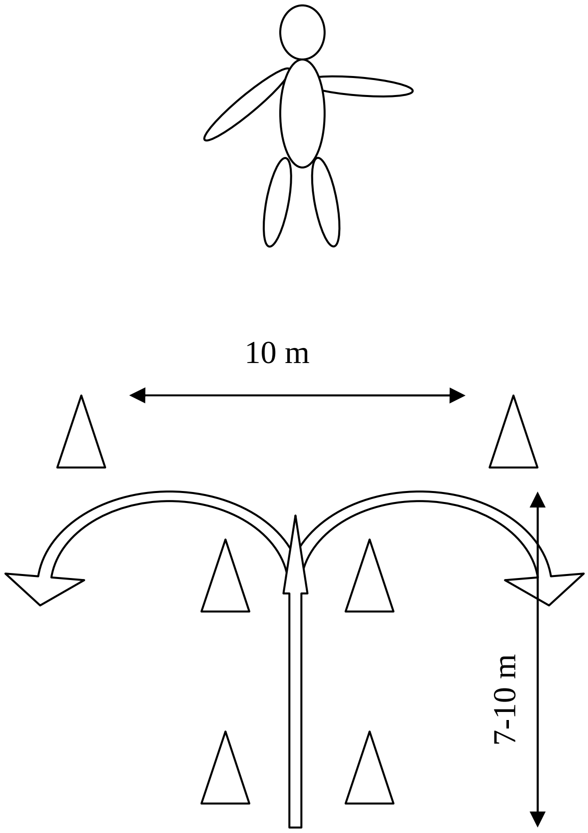
Without prior knowledge of which way to cut players run up the middle and are directed by a stimulus which way to cut

Stimulus is trainer that points to the direction of cut (run with ball in hand)

After making cut players make a 180 turn back to start as quickly as possible

Equipment

- Cones
- Footballs



Key point

- Respond as quickly as possible to trainer/player's command

PP COD (Double Forward)

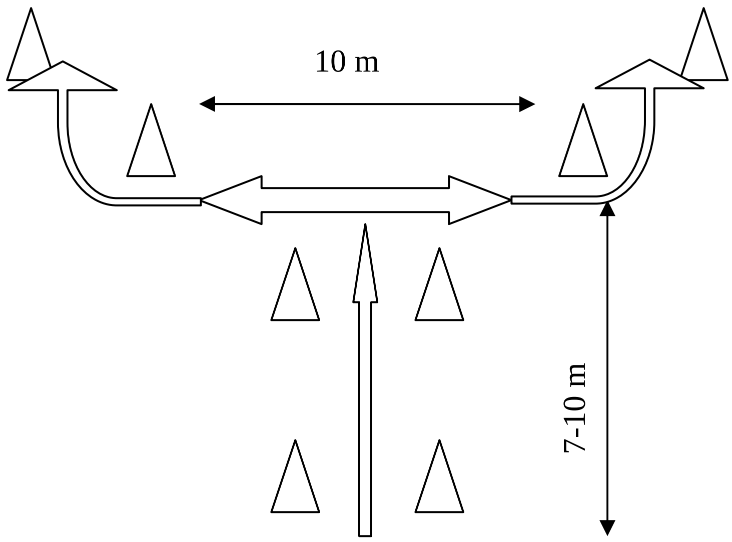
With prior knowledge of which way to cut players run up the middle and cut left or right, then cut right or left

i.e., if players first cut to the left they follow this with a cut to the right and vice versa

Players are to run with a ball in their hands

Equipment

- Cones
- Footballs



Key point

- Emphasise sharp sudden COD

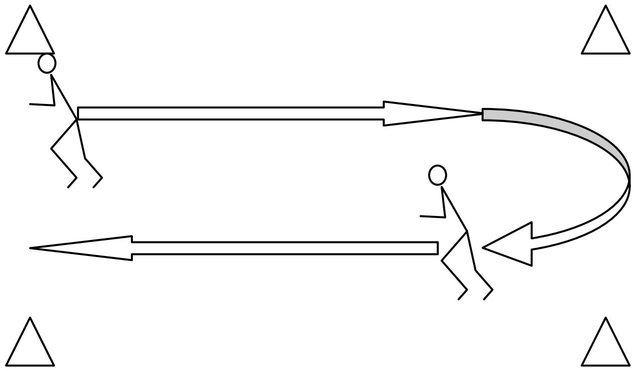
Backpedals (a) (15m)

Players backpedal (run backwards) for 15m

When they reach the end they sprint forward to the start as fast as possible

Equipment

- Cones



Key point

- Emphasise sharp sudden COD and good forward sprinting technique

Backpedals (b) (15m)

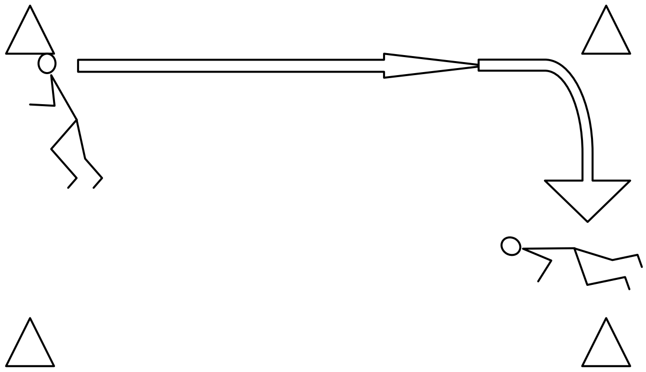
Players backpedal (run backwards) for 15m

When they reach the end they turn 90° and sprint to the side

Vary side to run to as required

Equipment

- Cones



Key point

- Emphasise sharp sudden 90° turn

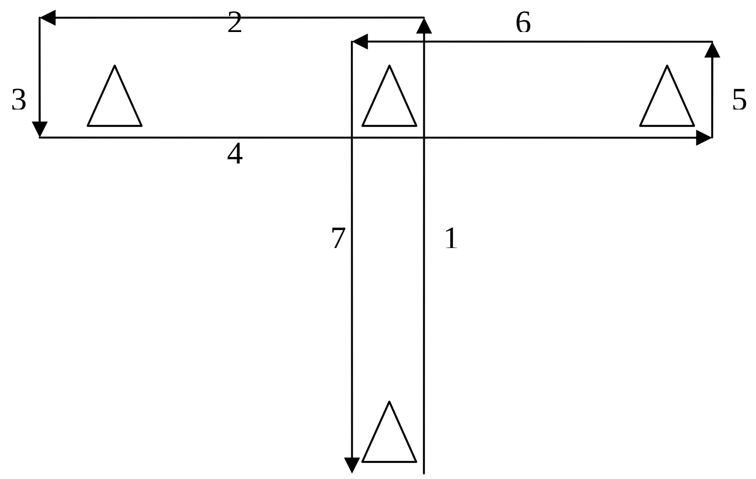
T-test

Players run through a standard T-test

Run forward around cone, turn 90 degrees left (or right), run forward, turn 180 degrees around cone, run past the middle cone, turn 180 degrees around the end, back to the middle turn 90 degrees and run back to the start.

Equipment

- Cones



Key point

- Complete task as quickly as possible

Training Exercises Rollout

PAFIX Training Program #2

Tim Doyle

Season 2007

Training Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25	26	27	28	29	30	31	32
Season Dates (Based on 2006)																																
Focus	Pre-Season 1				Pre-Season 2				In-Season 1					In-Season 2					Maintenance 1					Maintenance 2					Maintenance 3			
Intensity																																
Frequency	2 per week				2 per week				2 per week					2 per week					1 per week					1 per week					1 per week			

BASIC M'MENT TASK	SQUARES (10 M)
	WEAVING BOUNDS (A)
	WEAVING BOUNDS(B)
	SHUTTLE RUNS
	BUNNY JUMPS
	STANDING TRIPLES
GENERAL SPRINTING EXERCISES	SPRINTS (LYING START)
	RESISTED SPRINTS (5+15M)
	TEMPO RUNS
ACCELERATION/DECELERATION EXERCISES	KNEELING BEACH SPRINTS
	GRADUATED SPRINTS (20M)
	STOPPIES (10 + 2M)
COD/AGILITY EXERCISES	PP COD
	UP COD (180 TURN)
	PP COD (DOUBLE FORWARD)
	UP COD (DOUBLE FORWARD)
	BACKPEDALS (A) (15M)
	BACKPEDALS (B) (15M)
	T-TEST

Appendix C: PAFIX Recruitment Pack

General Project Information

Australian football consistently ranks as the sport with the highest number of presentations for injury treatment. The intense nature and physical demands of the game contribute to the high risk of injury. While injury preventive measures have been adopted to varying degrees, there is currently a lack of evidence for the effectiveness of these interventions and which are the best for preventing injuries to footballers. One common recommended strategy to reduce the number of injuries in football is a well-designed exercise training program. However, despite the potential of exercise programs for preventing injuries in football, the value of different types of programs has not been determined. There is a particular need for the development of exercise training programs for community level players as the majority of participants in the sport play at this level. This study will determine the effectiveness of different training programs for preventing injuries in community level football players by monitoring injury rates throughout the 2007 and 2008 seasons, and player behaviour and attitudes before and after the programs are implemented.

Your club has been invited to participate in this study of exercise training programs for preventing injuries in Australian football players. As a participating club, you will be assigned to one of two training programs. It is hoped that the findings of this study will determine which exercise training programs best prevent injuries in Australian footballers. These programs have already been proven in a laboratory setting and are now being applied to the real world. A trainer will be allocated to your senior and reserve teams to implement a specific training program during the warm-up phase of your training sessions. This trainer will attend all your training sessions and conduct the warm-up section of your session for senior and reserve grade players throughout the entire season. They will also attend all senior and reserve grade matches collecting participation and injury data. There will be no cost to your club for these trainers; they will be paid from the project funding.

This project is a randomised controlled trial involving senior and reserve grade community level football teams from Victoria and Western Australia. It is funded by the National Health and Medical Research Council (NHMRC) and is supported by Football Victoria, and the Western Australian Football Commission.

This is a collaborative project between researchers at the University of Ballarat and the University of Western Australia. The Chief Investigators are Professor Caroline Finch (University of Ballarat), Dr David Lloyd and Professor Bruce Elliot (University of Western Australia), and Project Managers are Dr Tim Doyle (University of Western Australia) and Dr Dara Twomey (University of Ballarat).

PREVENTING AUSTRALIAN FOOTBALL INJURIES THROUGH EXERCISE

THE UNIVERSITY OF WESTERN AUSTRALIA

Training Program Information

The training programs that we are evaluating are based around standard speed, plyometric, agility, and balance exercises. You will recognise many of the exercises in our programs and may already incorporate some of them into your current training. Our programs have been designed to be included at the start of a usual training session when you would normally complete your general and specific warm-up. After finishing the PAFIX program, which is expected to take no more than 20 mins, your players will be sufficiently prepared to commence their normal team and skills training.

We are evaluating two programs which are both based around the types of exercises mentioned above. Regardless of which program your team receives we are confident that your players and team will improve a combination of their speed, agility and general conditioning. Both programs have been designed using periodisation principles to take into account players' developing fitness and skill levels throughout the season and to limit impact on team and skills training as the season progresses; from about round 10 players will only be required to perform the PAFIX program at the start of one of their training sessions.

Early in the preseason, players will complete exercises such as 'Squares' which is classified as a 'Basic Movement Exercise'. This exercise is designed to simply get players used to moving in different directions and is probably the simplest of the exercises they will perform. As the training season, and the player's fitness and skill progresses, change of direction and agility exercises will be introduced where players will be required to side-step to the left or right as indicated by a verbal or visual cue, such as a team-mate pointing or handpassing a ball to the side. In total, there are about 20 different exercises in each program.

Throughout the season, your players will also be tested to determine their speed, agility, strength, balance and fitness. In order to assist with the planning of your own training we would suggest that these testing sessions be scheduled as a recovery, or light, session for your team; we will let you know in advance when we plan for these test sessions to occur. These tests are very similar, in fact some are the same, as those used by AFL clubs to monitor their players performance. Individual reports of these results, with interpretations of their meaning, will be provided to players and coaches with input from an AFL club consultant.

PAFIX
PREVENTING AUSTRALIAN FOOTBALL INJURIES THROUGH EXERCISE

UNIVERSITY of BALLARAT Australia

THE UNIVERSITY OF WESTERN AUSTRALIA

Benefits of Participating in the Project

- Warm-up trainer for the season free of charge
- An extra support staff, free of charge, to assist with your training sessions and games throughout the season
- Full training program instruction manuals
- Opportunity for you/your team to contribute to ongoing development of the game
- Access to the latest scientific knowledge before many other teams
- Partnering with Australia's leading football research team
- Regular updates on project progress and other football research updates
- Summary of your team's exposure, injuries and performance at the end of season
- Report on the study findings
- Access to the equipment used on the completion of the project in 2008

Expectations of Participating Clubs

- Nominate to be part of the project
- Support the project staff in the implementation of the exercise program, and fitness assessments
- Provide positive encouragement for players to comply with exercise program
- Allow project staff to do the warm-up section of your training sessions
- Arrange someone to supply the data collector with the team list at the match game every week and post match statistics
- Facilitate the testing of key performance measurements taken on 3 occasions between February and August

PAFIX
PREVENTING AUSTRALIAN FOOTBALL INJURIES THROUGH EXERCISE

THE UNIVERSITY OF WESTERN AUSTRALIA

Brief Introduction to the Research Team

Professor Caroline Finch

Professor Finch is an NHMRC Principal Research Fellow, at the University of Ballarat, whose research program has a primary focus on sports injury. Prof Finch is widely regarded both nationally and internationally as Australia's leading sports injury epidemiologist. She has been a lead investigator on many sports injury research projects with project funding totalling well over $7,000,000 since 1994. Her sports injury research has focussed on methodological advances in sports injury surveillance, evaluations of sports injury prevention measures and assessing attitudinal and behavioural barriers towards sports safety.

Dr David Lloyd

Dr Lloyd is one of the leading biomechanists in the fields of neuromuscular control of lower limb joint loading, and gait and movement analysis. He is a Senior Lecturer in the School of Human Movement and Exercise Science at the University of Western Australia. He has made major contributions to biomechanics research internationally, most significantly developing neuromuscular skeletal computer models that are capable of predicting subject-specific tissue loading in the knee joint during movement. The impact of Dr Lloyd's research is shown by attracting nearly $4,000,000 in project funding and being awarded the International Olympic Commission, Prince de Merode Award in 1999, amongst many other national and international awards. He has been invited to give key note presentations at numerous national and international conferences.

Professor Bruce C. Elliott

Professor Elliott is the senior biomechanist in the School of Human Movement and Exercise Science at the University of Western Australia. He has a keen interest in performance optimization and injury reduction in sport having published over 170 refereed articles, 50 refereed conference proceedings, along with 40 books or book chapters in this general area. He was the inaugural chair of the Western Australian Institute of Sport (1984-1994), and inaugural Vice-President (sport science) of the Australian Association of Exercise and Sport Science (1993-1995). In 1999 he was honoured with the Award of Merit by the Western Australian Sports Federation and in 2003 the Professional tennis Registry gave him the Stanley Plagenhoef Sport Science Award for "his lifetime contribution to tennis" and the Australian Government awarded him their Centenary Medal for service to sport policy and research development for sport".

Dr Tim Doyle

Dr Doyle completed his PhD in Sports Science through Edith Cowan University in Western Australia. Prior to this he completed his Master of Science (Exercise Science) in the USA at Ball State University and his undergraduate studies at the University of Queensland, Bachelor of Science (Human Movement Studies) – Honours. Currently he is a Post-Doctoral Fellow at the University of Western Australia, and prior to this he was a lecturer at Notre Dame University Australia in the Health and Physical Education program. His professional and academic collaborations extend both locally and internationally and include professional and amateur sporting teams. He is a qualified Strength and Conditioning coach and has been responsible for the State Junior Rugby Union squad in the Western Australian Institute of Sport. He is an active researcher and instructor in exercise and sports science publishing regularly in the field with over 30 publications and conference presentations.

Dr Dara Twomey

Dr Twomey recently commenced employment as a Research Fellow at the University of Ballarat, in the School of Human Movement and Sports Sciences. Prior to joining the University of Ballarat, she spent 4 years at the University of New South Wales in Sydney undertaking her PhD in Biomechanics, while working on various research projects. These included studies on kicking in Australian football, injuries in rugby union, the use of headgear in rugby union, and the biomechanical analysis of children with cerebral palsy. Dara commitment to her research has been rewarded through scholarships and travel awards and she has presented at many national and international conferences.

Formal Agreement

Club Name: ______________________________________

Club Address: _____________________________________
____
____
____

Contact Name: ____________________________________

Contact Phone Number: _____________________________

Please tick one of the following boxes

☐ Yes, we would like to participate in this study and understand the expectations of our club and players.

☐ We are not interested in participating in this study.

Please return this form in the postage paid envelope to Dara Twomey at the University of Ballarat by February 1st.

PROJECT INFORMATION

Australian football consistently ranks as the sport with the highest number of presentations for injury treatment. The intense nature and physical demands of the game contribute to the high risk of injury. While injury preventive measures have been adopted to varying degrees, there is currently a lack of evidence for the effectiveness of these interventions and which are the best for preventing injuries to footballers. One common recommended strategy to reduce the number of injuries in football is a well-designed exercise training program. However, despite the potential of exercise programs for preventing injuries in football, the value of different types of programs has not been determined. There is a particular need for the development of exercise training programs for community level players as the majority of participants in the sport play at this level. This study will determine the effectiveness of different training programs for preventing injuries in community level football players by monitoring injury rates throughout the 2007 and 2008 seasons, and player behaviour and attitudes before and after the programs are implemented.

There are five clubs from the Ballarat Football League participating in the project this year; namely Ballarat FC, Redan FC, Lake Wendouree FC, Sebastopol FC, and Darley FC. The project involves only the senior and reserve team in each club, however, in clubs where the under 18's have been preseason training together with the seniors they have also undertaken the exercise programs. In addition, there are seven teams of similar standard participating in Perth.

As participating clubs, they have been assigned to one of two training programs. It is hoped that the findings of this study will determine which exercise training programs best prevent injuries in Australian footballers. These programs have already been proven in a laboratory setting and are now being applied to the real world. Two trainers have been allocated to each club, for senior and reserve teams, to implement a specific training program during the warm-up phase of their training sessions. The trainers attend all training sessions and conduct the warm-up section throughout the entire season. They will also attend all senior and reserve grade matches, starting 25th April, collecting participation and injury data. The trainers are supplied to the club free of charge; they are paid from the project funding.

This project is funded by the National Health and Medical Research Council (NHMRC) and is supported by AFL Victoria, and the Western Australian Football Commission.

This is a collaborative project between researchers at the University of Ballarat and the University of Western Australia. The Chief Investigators are Professor Caroline Finch (University of Ballarat), Dr David Lloyd and Professor Bruce Elliot (University of Western Australia), and Project Managers are Dr Tim Doyle (University of Western Australia) and Dr Dara Twomey (University of Ballarat).

AN INNOVATIVE FOOTBALL TRAINING INITIATIVE

FACTS

- Knee injuries common in football
  - ACL contact
  - ACL non-contact
  - Others
- Improving musculature and general conditioning around knees can prevent injuries
- Scientific evidence that specifically targeted training conditioning programs are effective
- Evidence largely from overseas or lab-based studies

QUESTIONS

- Will they also work in Australian footballers in the field?
  - What training should they do?
  - Will footballers actually do the training?
  - Does the training make a difference?
  - Are there any impacts on performance?
  - Are knee injuries prevented or reduced?
  - Are there benefits for other body regions too?

HOW WE ARE GOING TO ANSWER THE QUESTIONS?

- $1.06 million from Commonwealth Govt (NHMRC)
- Leading-edge research team (UB and UWA)
  - injury prevention, injury surveillance, biomechanics, sports science, psychology
- Demonstrated track record in football research
- Formal partnerships with the VFL, etc
- Active involvement of coaches, clubs and players

STUDY

- Based in Vic and WA
- 2 years
- 10 teams each year
  - Preferably seniors/reserves
- Player information:
  - all playing and training exposures
  - All injuries
  - pre-season attitudes, beliefs
  - Compliance with training
  - Feedback on training programs

STUDY FORMAT

VICTORIA 10 teams		WA 10 teams	
5 clubs (S+R)	5 clubs (S+R)	5 clubs (S+R)	5 clubs (S+R)
TRAINING PROGRAM 1	TRAINING PROGRAM 2	TRAINING PROGRAM 1	TRAINING PROGRAM 2

WHAT CLUBS NEED TO DO

- Nominate to be part of the project
- Be an active participant
- "Support" the project staff
- Encourage players

WHAT COACHES NEED TO DO

- Let us do your warm-up sessions!
- Support the implementation of the exercise programme
- Positive encouragement for players to comply with exercise programme
- Supply or arrange someone to supply us with the match team list and post-game statistics

WHAT PLAYERS NEED TO DO

- Participate in pre-season and in-season training as normal
- Participate in our warm-up programme
- Have key performance measurements taken 3-4 times
- Play as normal
- Complete a pre-season and end-of-season survey

WHAT WILL YOU GET FREE?

- EQUIPMENT
  - All training equipment
  - All equipment will be donated to VFL coach resources at end of 2 years
- PERSONNEL
  - To run your warm-up sessions at training
  - To assist you with the rest of the training session and games
  - To collect all injury/exposure data and the player surveys
- DOCUMENTATION
  - Full training programme instruction manuals
  - Full injury surveillance documentation
  - All necessary paper work

WHY SHOULD YOU PARTICIPATE?

- Opportunity for you/your team to contribute to ongoing development of the game
- Demonstrated commitment to duty of care to players
- Access to the latest scientific knowledge before many other teams
- Partnering with Australia's leading football research team
- Ongoing access to the equipment used on the completion of the study
- Regular updates on project progress and other football research updates
- Summary of your team's exposure, injuries and performance at the end of season
- Report on the study findings

Appendix D: Published Manuscript

REVIEW ARTICLE

Sports Med 2010; 40 (10): 841-858
0112-1642/10/0010-0841/$49.95/0

The Extent to Which Behavioural and Social Sciences Theories and Models are Used in Sport Injury Prevention Research

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School of Human Movement and Sport Sciences, University of Ballarat, Mt Helen, Victoria, Australia

Contents

Abstract

Behavioural and social science theories and models (BSSTM) can enhance efforts to increase health and safety behaviours, such as the uptake and maintenance of injury prevention measures. However, the extent to which they have been used in sports injury research to date is currently unknown. A systematic review of 24 electronic databases was undertaken to identify the extent to which BSSTM have been incorporated into published sports injury prevention research studies and to identify which theories were adopted and how they were used. After assessment against specific inclusion and exclusion criteria, the full text of 100 potentially relevant papers was reviewed in detail. These papers were classified as follows: (i) explicit – the use of BSSTM was a stated key aspect in the design or conduct of the study; or (ii) atheoretical – there was no clear evidence for the use of BSSTM. The studies that explicitly mentioned BSSTM were assessed for how BSSTM were specifically used. Amongst the 100 identified papers, only eleven (11% of the total) explicitly mentioned BSSTM. Of these, BSSTM were most commonly used to guide programme design/implementation (n = 8) and/or to measure a theory/construct (n = 7). In conclusion, very few studies relating to sport safety behaviours have explicitly used any BSSTM. It is likely that future sports injury prevention efforts will only be enhanced, and achieve successful outcomes, if increased attention is given to fully understanding the behavioural determinants of safety actions. Appropriate use of BSSTM is critical to provide the theoretical basis to guide these efforts.

1. Introduction

There has been, and continues to be, widespread concern about sport and recreational (hereafter referred to as sport) injury worldwide.[1-8] Prevention of sport injuries is a complex process because of the multi-factorial nature of their causes and risk factors.[9,10] Accordingly, a multidimensional approach is required to address the problem and this must be implemented within the context of the prevailing sports culture and player behaviours.[11-13] Although a range of injury prevention measures have been evaluated within sport,[14,15] a lack of rigorous, directed behavioural and social sciences research into sport injury prevention, either in isolation or in combination with other approaches, has been suggested as contributing to difficulties in achieving uptake and dissemination of effective preventive measures.[12,16,17] While there has been increasing attention directed at establishing the efficacy of many and varied sport injury measures or interventions to prevent injury, much less attention has been given to the development of, and research into, effective methods for broader uptake, dissemination and diffusion of interventions in this context.[12,13,18]

A recent systematic review[17] has emphasized the lack of behavioural and social science theories and models (BSSTM) being applied to unintentional injury prevention in general. These authors noted the paradox that while integration of BSSTM in other health research areas has grown significantly over recent years, it does not yet appear to have been adopted widely by injury prevention researchers.[17] Several other publications in the general injury prevention area have also emphasized the need to integrate BSSTM with the development of injury interventions.[19-22] More recently, in the context of sport, Finch[12] highlighted research into this area as a key knowledge requisite in her Translating Research into Injury Prevention Practice (TRIPP) framework.

The importance of BSSTM is that they can provide tools for moving beyond intuition about what might work, or efficacious evidence from controlled trials, to the design and evaluation of interventions requiring adoption and maintenance of safety behaviours in the real world. They do this by providing a theoretical and conceptual basis for understanding safety behaviours and their determinants,[19,23-25] thereby presenting a systematic way of better understanding the events or situations that can explain or predict injury events, as well as the relationships between them.[23] Models draw on a number of theories to help understand a particular problem in a certain setting or context,[23] as, for example, was recently applied to understand protective eyewear behaviours in squash players.[24]

Using BSSTM as a foundation for the development of interventions and planning for their delivery is consistent with the rationale for broader-based evidence-based interventions in public health and behavioural medicine.[19,23,25] Use of behavioural theory, in particular, provides a framework for studying problems, identifying target groups and behaviours for intervention, developing appropriate interventions, measuring change in relevant behaviours and for evaluating intervention success.[19] In turn, this can lead to greater insights for programme planners and implementers to translate stronger programmes with higher uptake. Considerations from BSSTM framed within an ecological framework contribute to this by explaining the dynamics of safety behaviours, including processes for changing them and both the positive and negative influencing factors associated with both social and physical environments.[24] It has been argued that intervention programme planning, implementation, and evaluation processes based on BSSTM are more likely to succeed than those developed without the benefit of a theoretical perspective.[19,26]

As these approaches work for general public health and other safety initiatives, it would seem likely that they would also make a significant contribution to the prevention of sports injuries.[24,27] Although a number of recent systematic reviews of sport injury prevention measures shown to be efficacious have been reported,[14,15,28-32] none have described the role of BSSTM in the reviewed interventions, even though almost all interventions trialled to date have required some form of behaviour change on the part of a player, athlete or coach. In contrast, there is a major knowledge gap in relation to the effectiveness, or real-world uptake, of sports injury prevention interventions. This article reviews and summarizes the extent to which use of BSSTM has been reported across a range of sports injury prevention studies, as a precursor to better understanding intervention effectiveness. In doing so, it identifies which BSSTM have been most commonly used to date and categorizes the theoretical contexts in which they have been applied.

2. Methods

2.1 Search and Selection Strategies

A comprehensive electronic database search strategy was developed to identify relevant published literature associated with BSSTM and sport injury prevention from the following 24 somewhat overlapping electronic databases: 'Academic Search Premium', 'AUSPORT', 'AUSPORTMed', 'Health Science Consumer', 'Health Source: Nursing', 'SportsDiscus® with full text', 'SpringerLink', 'Web of Science', 'Web of Knowledge', 'JSTOR', 'PsychArticles', 'PsycINFO', 'Psychology + Behaviour', 'Psychoanalytic Electronic Publishing (PEP)', 'CINAHL Plus with text', 'Meditext', 'Wiley Interscience', 'APA-FT', 'PubMed', 'BMJ Journals Online', 'Electronic Journals (EBSCO)', 'Science Direct', 'Informaworld' and 'MEDLINE'. The search covered all items in each database (including 'in press' items) from the earliest records available until July 2009.

An initial broad search filter was completed using three keywords: 'sport', 'injury' and 'prevention'. Initial searches combined this injury filter with keywords reflecting BSSTM including the names of common BSSTM (e.g. Health Belief Model) identified from the broader injury prevention, health behaviour and health promotion literature.[19,23,25,33,34] The search was further refined and expanded to capture other potential studies through the use of specific keywords (in isolation or in combination) chosen as relating to the following: (i) BSSTM constructs – 'attitude', 'perceptions', 'social norms', 'perceived behavioural control', 'perceived severity/susceptibility', 'barriers', 'knowledge', 'self-efficacy', 'behavioural capability', 'reinforcement', 'environment', 'empowerment', 'motivation', 'antecedents', 'behaviour', 'adoption', 'maintenance', 'implementation', 'intrapersonal/interpersonal', 'organizational/community'; (ii) common sports injury prevention measures – 'protective equipment', 'mouthguards', 'headgear', 'eyewear', 'faceguards', 'warm-up', 'education', 'training', 'exercises (including biomechanical and neuromuscular)'; (iii) specific sports activities – 'football', 'hockey', 'soccer', 'rugby', 'squash', 'netball', 'basketball', 'tennis', 'volleyball', 'handball', 'baseball', 'softball', 'athletics', 'badminton', excluding cycling/bicycling; and (iv) terms – 'survey/questionnaires', because these are commonly used tools in BSSTM studies. The Cochrane Database of Systematic Reviews (www.cochrane.org) was also checked to ensure that no similar review was in existence there.

Figure 1 summarizes the systematic process underpinning the review search strategy and the numbers of relevant papers identified and retained at each stage. In the initial stage, all potential articles were identified upon a preliminary review of titles, abstracts and keywords screened according to the defined broad search criteria. All duplicate articles were removed. Any study not exactly matching the stated exclusion criteria was kept for further full text review. Hand searching of the reference lists, individual journals, and identified review papers was undertaken to identify any further relevant studies not retrieved via the initial database searches. An author and citation search was also conducted to identify further studies undertaken by authors of the retained studies. The final studies identified for more detailed review were assessed against a checklist of specified inclusion/exclusion criteria (see Appendix 1 of the Supplemental Digital

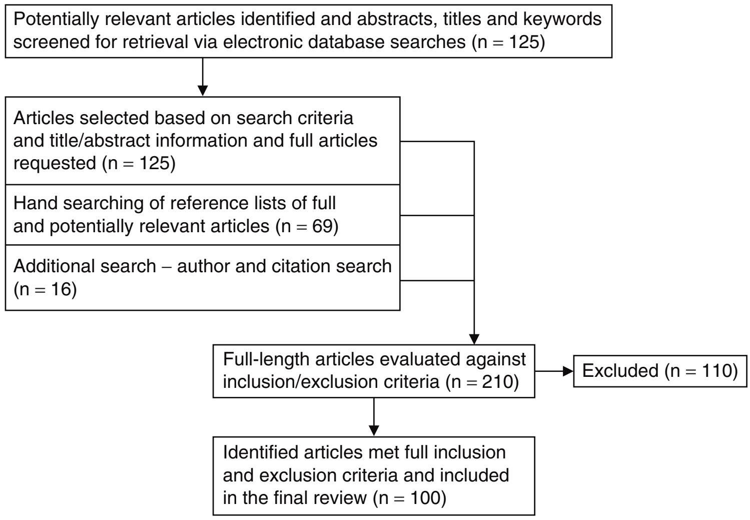

Fig. 1. Summary of the systematic literature search strategy and the numbers of studies selected or excluded at each stage.

Content 1, http://links.adisonline.com/sportsmedicine/SMZ/A5).

To be retained for final review, an article had to focus on a sport injury prevention measure and mention some aspect of safety behaviours (e.g. mouthguard use) as well as some behavioural determinant/s in relation to the measure (e.g. attitudes). Specific inclusion and exclusion criteria were developed and agreed to by the authors. Full text articles were obtained and their content assessed to determine whether they met the stated inclusion/exclusion criteria (as listed in table I).

2.2 Classification and Review of Selected Studies

The lead author (AMcG) summarized the key characteristics of the selected studies and classified the use of BSSTM in the studies where applicable. For studies reporting use of BSSTM, details were recorded for the particular BSSTM reported and how they were used.

In the first stage, the use of BSSTM in the selected studies was categorized as belonging to only one of the following categories:

- Explicit: whereby, BSSTM were a clearly stated key aspect in the design or conduct of the study. Studies assigned to this category were required to state that BSSTM were used and to specifically mention the name of the theories or models.
- Atheorectical: where there was no clear evidence for the use of BSSTM in the design or conduct of the study (including unrelated to, lacking a theoretical basis or somewhat implied though not plainly expressed). For example, a number of studies only implied or presented information potentially relating to one or more BSSTM constructs such as risk perceptions, safety attitudes, self-efficacy or perceived behavioural control, with no direct relevance to BSSTM. In these studies, it was not evident whether the particular 'construct' used by the authors had been chosen by chance or because of its theoretical basis.

Based on the information provided in the papers, each author independently classified all studies according to the BSSTM use. Any discrepancies in the classifications were resolved through consensus discussion.

In the second stage, studies classified as having explicit BSSTM use were summarized and assessed against the Trifiletti et al.[17] categorization of BSSTM use. This categorization allowed studies to be classified in more than one category. Application of the Trifiletti et al.[17] categorization required use of BSSTM in these studies to be rated as follows:

Table I. Inclusion and exclusion criteria for selecting papers to be included in the systematic review

Inclusion criteria	Exclusion criteria
Full-text (complete) peer-reviewed, English language, earliest records to July 2009	Studies relating to chronic, recurrent or illness-related conditions
Original research studies	Studies not published in the peer-review literature, reports, reviews, theses and conference proceedings: not reported as full peer-reviewed paper
Studies relating to all ages and both sexes	Intervention/prevention measure studies not considering prevalence of use and determinants of safety behaviour
Sports activities (team/individual) in formal, competitive and social/recreational settings	Bicycle-related studies, including bicycle helmet use studies[a]
Related to the prevention of acute or traumatic injuries	Reviews or commentaries on injury prevention interventions, even if peer reviewed
Unintentional injury	Studies relating to violence-related behaviours or intentional injuries
Target populations – e.g. sports participants (athletes, players), coaches, officials, parents (or significant others)	
Studies specifically related to specified safety behaviours or behavioural interventions to prevent acute sport injury – e.g. protective equipment, warm-up	
Mention of behavioural and social sciences themes, aspects or approach	

a Bicycle-related studies were excluded from this review because it is not clear to what extent the bicycling activity described would be related to sport and active recreation, rather than to transportation. Even though this means that many studies of bicycle helmets have been excluded from this review, it is appropriate because most of those helmet-wearing interventions were implemented and assessed in the context of road safety initiatives rather than sports safety.

(a) Theory was used to guide programme design and/or implementation and/or to select programme measures.
(b) Measurement of a theory or construct or model was undertaken (e.g. data was provided that described predisposing or enabling factors of player safety practices).
(c) A theoretical construct or an extension of a theory (i.e. whether changes or variation in outcomes as predicted by models) was tested (e.g. whether the theory of reasoned action was helpful in understanding variations in beliefs, attitudes, subjective norms and safety practices).
(d) Other: the use of BSSTM did not conform to the aforementioned categorization or when the study authors did not adequately explain the role of theory or models.

The categories (a) to (c) represent Trifiletti et al's.[17] increasing levels of theory application, from (a) low to (c) high, whilst the 'other' category (d) did not correspond to a 'level' of theory application.

3. Results

3.1 Prevention Measures in Sport Injury Prevention Research

Table II shows the total number of potential studies identified, total exclusions and inclusions, and the number of studies according to prevention measure categories.

3.2 Summary Characteristics of the Reviewed Studies

Table III summarizes the characteristics of the 100 studies that met the inclusion criteria. Most studies (n = 74) related to personal protective equipment (PPE) as the major injury prevention measure. The sporting activities varied from team ball sports, to team bat and ball sports, racquet sports, target and precision sports, individual water sports, individual athletic activities, equestrian activities and wheeled non-motorized sports. Most studies focused on the athletes/players themselves (n = 61 studies) but other common groups were coaches (n = 11), officials (n = 4) and dentists (n = 4). Sixteen studies related to multiple types of participants.

Table III also indicates the categorization of each study according to its use or non-use of BSSTM. Overall, of the 100 studies that met the inclusion criteria, only eleven (11%) studies mentioned *explicit* use of BSSTM.

3.3 Theories and Models Used in Sport Injury Prevention Research

Table IV summarizes the specific BSSTM used in the eleven studies stating explicit use. Of the studies that explicitly mentioned BSSTM, seven were related to the use of PPE.[16,24,38,39,41,58,107] Only the Theory of Reasoned Action/Theory of Planned Behaviour[39,107,109,122] and Diffusion of Innovation[58,129] were used in more than one study. When explicit studies were rated according to the Trifiletti et al.[17] categorization of BSSTM use, it was apparent that the majority (n = 8) had used BSSTM to guide programme design and/or implementation, or to measure a specific theory or a theoretical construct (n = 7); only four studies formally tested a theory and three studies did not meet any of the aforementioned criteria and was specified as 'other'.

4. Discussion

It is critical that sports safety interventions have a strong evidence-base for their efficacy and effectiveness before they are delivered to players, coaches and sporting bodies. It is equally important that they are both effective from a public health perspective and can be readily adopted and maintained in the 'real world'. Although it is now accepted that behavioural approaches are useful for understanding, explaining and changing behaviour related to injury problems[19,21] and are an important consideration in intervention effectiveness,[13] this review highlights the lack of BSSTM applications to published sport injury prevention research. This is a concern because most solutions to preventing the sport injury problem rely on some form of behaviour change or modification on the part of players, athletes, coaches, officials, administrators or peak sports bodies.[12,16,18,24] Whilst this review found quite a large number of studies relating to sport injury prevention measures with some behavioural basis, only 11% applied any formal theoretical considerations to their study, suggesting that most authors in this area are either not aware of the importance of BSSTM, or do not appreciate the value of theoretical underpinnings and their application to practice, or may simply lack the knowledge, expertise or requisite skills/training to utilize them.

When BSSTM were used in the published sports injury studies, this tended to be in relation to individual-level (intrapersonal/interpersonal) theories. These included the Health Belief Model,[38,131] Theory of Reasoned Action/Theory of Planned Behaviour,[39,107,109,122,132] Attitude-Social Influence Self Efficacy (ASE) model (an elaboration of the Theory of Planned Behaviour),[41,133] and Social Cognitive Theory.[16,134] This is quite appropriate and not surprising given the focus on ensuring the safety of individuals involved either in team sports or as individual participants of activities such as skating. However, recent commentary has stressed that it is more than just individual (i.e. player) factors that affect uptake and adoption of safety measures, and hence sustained behaviour change.[13] Such factors relate to the capacity of the full sports delivery system to deliver and implement preventive measures for the benefits of sports participants.[13]

Table II. Overall summary of identified sport injury prevention measure studies at different stages in the review process

Prevention measure	No. of potential studies	Total studies excluded	Total studies included	Atheoretical studies	BSSTM explicit studies (%[a])
Equipment	7	5	2	1	1 (50.0)
Multi-focused	6	0	6	4	2 (33.3)
General IP	5	0	5	4	1 (20.0)
Education	8	2	6	5	1 (16.7)
Protective equipment	109	36	74	68	6 (8.2)
Specialized exercise	74	67	7	7	0 (0.0)
Total	**210**	**110**	**100**	**89**	**11 (11.0)**

a % denotes BSSTM out of total studies included per prevention measure.

BSSTM = behavioural and social science theories and models; **IP** = injury prevention.

Table III. Characteristics of the 100 studies included in this review and classification of their use of behavioural and social science theories and models (BSSTM)

Safety behaviour[a]	Country of study	Categorizations of BSSTM use and sport; level of play[b]		Study focus	Reference
		atheoretical	explicit		
PPE, general	Australia	Australian football; adult/community		Players	35
PPE, general	USA	Rugby (female); various		Players	36
PPE, general	Ireland	Hurling; adults/inter-county		Players	37
PPE, general	USA		Various sports (12 sports); junior/high school (athletes)	Players, coaches	16
PPE, general	USA		In-line skating; adult/recreational	Participants	38
PPE, general	France		In-line skating; adult/non-specific	Participants	39
PPE, general	USA	In-line skating, skateboarding and snowboarding; junior/adolescent extreme sports		Participants	40
PPE, general	The Netherlands		In-line skating; junior/children recreational to high performance	Participants	41
PPE, general	India	Various sports; junior to adult/high school, college and university		Coaches	42
PPE, eyewear	Australia	Squash; adult/competitive and social/recreational		Players	43
PPE, eyewear	Australia	Squash; adult/competitive and social/recreational to state		Players	44
PPE, eyewear	Australia	Squash; adult/competitive and social/recreational		Players	45
PPE, eyewear	Australia	Squash; non-specific level		Players	46
PPE, eyewear	Australia	Squash; adult/competitive and social/recreational		Players	47
PPE, eyewear	Australia	Squash; non-specific level		Venue operator	48
PPE, eyewear	Australia		Squash; non-specific	Players, venue managers	24
PPE, eyewear	Australia	Squash; adult (pennant)		Players	49
PPE, facial protection	USA	Ice hockey (indoor); adult/recreational		Players	50
PPE, faceguard	USA	Baseball; junior/youth league		Players, coaches and parents	51
PPE, headgear	Australia	Rugby union; junior/interschool		Players	52
PPE, headgear	Australia	Australian football; adult/amateur/community		Players	53
PPE, headgear	USA	Rugby union; adult/university		Players	54
PPE, headgear	Australia	Surfing; non-specific level		Participants	55
PPE, headgear	USA	Organized equestrian; non-specific level		Participants	56
PPE, headgear	USA	Wrestling; collegiate/division 1		Wrestlers	57
PPE, headgear	USA		Skiing and snowboarding; adult/non-specific	Participants	58
PPE, headgear	USA	Skiing; adults/non-specific		Ski-shop owners	59
PPE, headgear	USA	Skiing and snowboarding; adults/non-specific level		Ski patrollers	60

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Table III. Contd

Safety behaviour[a]	Country of study	Categorizations of BSSTM use and sport; level of play[b]		Study focus	Reference
		atheoretical	explicit		
PPE, headgear	Canada	Rugby union; junior to adults/high school to national level		Players, coaches	61
PPE, mouthguards	Australia	Rugby; adult/elite international		Players	62
PPE, mouthguards	Australia	Rugby; adult/elite international		Players	63
PPE, mouthguards	Australia	Rugby; adolescents/high school (private)		Players	64
PPE, mouthguards	Australia, Scotland, Ireland, Wales	Rugby; adult/elite international		Players	65
PPE, mouthguards	UK	Rugby; adult/elite international		Players	66
PPE, mouthguards	UK	Rugby; non-specific level		Players	67
PPE, mouthguards	UK	Rugby league; adult/elite super league		Players	68
PPE, mouthguards	UK	Rugby; adult/various levels		Players	69
PPE, mouthguards	USA	Rugby; adult/elite international		Players	70
PPE, mouthguards	USA	American football; adult/university (freshman)		Players	71
PPE, mouthguards	USA	Football; junior/high school varsity		Players	72
PPE, mouthguards	USA	Football; junior/high school varsity		Players	73
PPE, mouthguards	USA	Basketball; junior/high school varsity		Players	74
PPE, mouthguards	Australia	Basketball; junior to adult/social to elite		Players	75
PPE, mouthguards	China	Basketball; adult/professional and semi-professional		Players	76
PPE, mouthguards	USA	Ice hockey; adult/university NCAA men's division 1		Players	77
PPE, mouthguards	USA	Ice hockey; junior/high school		Players	78
PPE, mouthguards	UK	Field hockey; adult/elite premium division		Players	79
PPE, mouthguards	Turkey	Tae Kwon Do; junior/elite		Players	80
PPE, mouthguards	Japan	Various sports (4 sports); adolescents/high School		Players	81
PPE, mouthguards	Singapore	Various sports; junior/high school		Players	82
PPE, mouthguards	Nigeria	Various sports; junior to adult		Players	83
PPE, mouthguards	USA	Various sports; junior/high school		Coaches	84
PPE, mouthguards	Nigeria	Various sports; junior/high school		Coaches	85
PPE, mouthguards	Switzerland	Various sports; adult/national level		Players, officials	86
PPE, mouthguards	Brazil	Various sports; adult/semi-professional to professional		Players	87
PPE, mouthguards	USA	American football; adult/university NCAA division I-A		Coaches	88
PPE, mouthguards	USA	Ice hockey; adult/university NCAA division I, II, and III, and independent varsity ice hockey programme		Athletic trainers	89

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Table III. Contd

Safety behaviour[a]	Country of study	Categorizations of BSSTM use and sport; level of play[b]		Study focus	Reference
		atheoretical	explicit		
PPE, mouthguards	USA	Football; adult/university NCAA division I-A		Officials	88
PPE, mouthguards	USA	Football; adult/university NCAA division I-A		Officials	90
PPE, mouthguards	USA	Soccer; junior/competitive		Parents	91
PPE, mouthguards	USA	Various sports; junior/public school		Parents	92
PPE, mouthguards	USA	Soccer; junior/non-specific		Parents	93
PPE, mouthguards	USA	Various sports; non-specific		Dentists	94
PPE, mouthguards	USA	Various sports; non-specific level		Dentists	95
PPE, mouthguards	Singapore	Various sports; non-specific level		Dentists	96
PPE, mouthguards	Nigeria	Various contact sports; non-specific level		Dentists	97
PPE, mouthguards	Turkey	Various sports; junior/high school coaches and university athletes		Coaches, players	98
PPE, mouthguards	Turkey	Various sports; adult/university coaches and players		Coaches, players	99
PPE, mouthguards	Switzerland and Germany	Handball; adult/amateur, semi-professional		Coaches, players	100
PPE, mouthguards	Switzerland, Germany and France	Squash; junior, adult/juniors, amateur, semi-professional and professional		Coaches, players	101
PPE, mouthguards	USA	Football; junior/high school varsity		Coaches, trainers	102
PPE, mouthguards	UK	Rugby union; adult/elite players and community level parents of junior players		Players, parents	103
PPE, mouthguards	Australia	Australian football; junior to adult/amateur		Players, spectators (family and friends)	104
PPE, mouthguards	USA and Canada	Ice hockey; junior to senior/all levels		Players, trainers, dentists	105
Equipment, safety baseballs	USA	Baseball; junior/little league		President	106
Equipment-ski bindings	USA		Skiing; adult/non-specific	Skiers	107
General injury prevention	UK	English football (soccer); adults/professional non-specific level		Players	108
General injury prevention	Australia		Australian football; junior/elite	Players	109
General injury prevention	USA	Ice Hockey; junior/non-specific level		Players	110
General injury prevention	Australia	Little athletics; junior/non-specific level		Participants	111
General injury prevention	Australia	Rugby union; junior/community		Coaches	112

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Table III. Contd

Safety behaviour[a]	Country of study	Categorizations of BSSTM use and sport; level of play[b]		Study focus	Reference
		atheoretical	explicit		
Specialized exercise, tackling 'spearing' and rule enforcement	USA	American football; junior/high school		Officials	113
Specialized exercise, tackling 'spearing'	USA	Football; junior/high school level		Players, coaches	114
Specialized exercise, warm-up	Australia	Golf; adult/non-specific level		Players	115
Specialized exercise, pre-exercise stretching	USA	Various sports; junior/high school level		Coaches	116
Specialized exercise, intervention	USA	Soccer; NCAA division 1 (female)		Coaches	117
Specialized exercise, non-intervention	Australia	Australian football; adult/elite		Coaches	118
Specialized exercise, non-intervention	UK	Cricket; adult/first-class county		Coaches	119
Multi, non-intervention (SEE)	Australia	Skiing/snowboarding; adults/various levels (beginners/intermediate/advanced)		Skiers	120
Multi, intervention	New Zealand		Rugby union; population wide	Multi-focused	27
Multi, intervention	USA	Skiing/snowboarding; junior, adult/non-specific level		Multi-focused	121
Multi, non-intervention (SEE)	USA		Basketball; high school varsity, junior varsity, division III Massachusetts South Coast conference coaches	Players, coaches	122
Multi, non-intervention (SEE)	New Zealand	Soccer; junior		Players	123
Multi, non-intervention (SEE)	Australia	Skiing/snowboarding; adults/various levels (beginners/intermediate/advanced)		Skiers	124
Education intervention	The Netherlands	Running; adults/non-specific		Runners	125
Education intervention	The Netherlands	Skiing; various participants/levels (beginners to advanced)		Skiers	126
Education intervention	Australia	Soccer; adults/various club officials		Officials	127
Education intervention	New Zealand	Netball and soccer; various levels/non-specific level		Coaches	128
Education intervention	USA		Various sports; adolescent/high school athletic coaches	Coaches	129
Education intervention	Australia	Basketball and rugby; junior/non-specific		Players, coaches parents	130

a General PPE refers to multiple types of PPE considered in the one study, e.g. helmets, wrist guards, knee and elbow pads.

b Non-specific denotes authors did not specify level of sport.

NCAA = National Collegiate Athletic Association; **PPE** = personal protective equipment; **SEE** = specialized exercise and education.

Table IV. Summary of behavioural and social science theory and models (BSSTM) explicitly stated as being used in sports injury research studies

BSSTM	Safety behaviour under investigation	Trifiletti et al. categorization[17] of BSSTM use	References
Health Belief model	Protective equipment	Tested theory	38
Theory of Reasoned Action/Theory of Planned Behaviour	General injury Prevention	Guided programme design and/or implementation; measured theory or construct	109
Theory of Reasoned Action/Theory of Planned Behaviour	Multi-intervention (SSE)	Measured theory or construct	122
Behavioural Intention model (otherwise known as Theory of Reasoned Action)	Equipment, ski bindings	Guided programme design and/or implementation; measured theory or construct; tested theory	107
Theory of Reasoned Action/Theory of Planned Behaviour (including threat perceptions)	Protective equipment	Guided programme design and/or implementation; measured theory or construct; tested theory	39
Social Cognitive Theory	Protective equipment	Guided programme design and/or implementation; measured theory or construct	16
Attitude-Social Influence Self-Efficacy model	Protective equipment	Guided programme design and/or implementation; tested theory	41
Refined Ecological model	Protective eyewear	Guided programme design and/or implementation; other	24
Diffusion of Innovation Theory	Protective headgear	Other	58
Diffusion of Innovation Theory	Coach education, general injury prevention	Guided programme design and/or implementation; measured theory or construct	129
PRECEDE-PROCEED model[a]	Multi-intervention	Guided programme design and/or implementation; measured theory or construct	27
Ottawa Charter[a]	Multi-intervention	Other	27

a PRECEDE-PROCEED model and Ottawa Charter applied in the same study;[27] (identified 12 BSSTM; n = 11 studies).
SEE = specialized exercise and education.

Despite the increasing availability of evidence-based sports injury prevention measures, sports safety efforts to date have been hampered because limited research attention has focused on understanding the intervention implementation context and processes, including barriers and facilitators to sustainable programmes.[12,13,18] This knowledge gap requires not only the use of individual-level theories but also the application of organization- and community-level theories. Our review has confirmed that organizational- and community-level theories have rarely been used, with the exception of a refined Ecological model,[24] the Diffusion of Innovation Theory,[58,129] the PRECEDE-PROCEED planning model[27] and the Ottawa Charter.[27] Further application of BSSTM at multiple-levels of behavioural influence (i.e. aligning individual, organizational and community) in this area of research should strengthen the design of intervention strategies and ensure sustainability of implemented programmes. Their direct application could be used to develop different intervention strategies and methods when working with either individuals or communities[19,25] in different sports settings. For example, at the individual level, intervention strategies could include a variety of behavioural, educational, counselling, skills development and training methods.[25,135] At the organizational and community level, the use of social marketing, mass media and media advocacy are important, as well as coalition building, social planning and community development.[25,135]

Another significant gap highlighted by this review is that many of the common theories from the behavioural literature were not identified in the reviewed sports injury studies; these include the Protection-Motivation Theory,[136] Stages of Change/Transtheoretical model,[135,137] Precaution Adoption Process model,[138] Applied Behavioural Analysis,[19] Social Networks and Social Support,[139] Self Efficacy,[140] Community Organisation and Mobilisation Theories (including Empowerment, Capacity, Participation and Relevance),[141] Communication Theories,[142] Organisational Development Theory (including Organisational Culture, Climate and Capacity),[143] the RE-AIM (Reach, Effectiveness-Adoption, Implementation and Maintenance) model[144] and Social Marketing.[145] Given the success of application of these BSSTM to other safety behaviours and health issues,[146,147] there could be considerable merit in also applying them to the sports injury context.[13] For instance, the Applied Behavioural Analysis[19,25] theory has been used in many injury settings (e.g. road safety,[148,149] child safety,[150] and occupational settings[151]) to change behaviour, but has yet to be applied to sports injury. Unlike the review conducted by Trifiletti et al.,[17] which found the PRECEDE-PROCEED planning model was most commonly used in unintentional injury prevention, our study has highlighted that this model has only been used in one sports injury prevention study to date.[27] The reasons for this are unclear, but could reflect the relative infancy of the application of BSTTM underpinnings to sports injury prevention.

All BSSTM can be applied at various stages of the research process. We applied the Trifiletti et al.[17] categorization to ascertain how theory had been used in the sports injury studies that adopted it. The most common application was used to guide programme design and/or implementation, and/or select programme measures of a study. This implies a low level of theory application according to Trifiletti et al.,[17] and demonstrates a significant absence of the systematic application of BSSTM to sports injury research. Most studies that did apply theory to programme design were also categorized as measuring a theory, construct or model, thereby strengthening their theory application moderately. There was little evidence of testing theories, to determine what might be most applicable to the sports injury context. Without this information, researchers who want to apply BSSTM appear to just select random constructs that they think may be relevant, without formal justification or rationale for their choice.

Often it seems that sport injury studies address constructs relevant to behaviour change in general, but there is little evidence of studies actually committing to the application of specific theory and systematically designing methods, such as questionnaires, accordingly. This is reflected in the large number of atheoretical studies. This could indeed lead to results that are neither replicable nor generalizable to other player groups or different interventions. Moreover, atheoretical studies are unlikely to build on existing behavioural knowledge and run the risk of omitting important psychosocial determinants and processes central to behaviour change. Although theory-based studies are more likely to provide a strong empirical foundation for evidence-based prevention approaches, this does not mean that nothing can be learnt from theoretical approaches. There is still a role for them in informing future theoretical studies, guiding implementation efforts and highlighting future research questions.

4.1 Limitations

Although an extensive search strategy was adopted, it is possible that the ability to locate relevant papers for the review was limited by the use of specific keywords or series of keywords. Using search terms relating to common theories only resulted in two studies being found; these two studies were also identified using alternative search terms. This restriction to only common theories may have limited identification of other useful or newly emerging theories. However, we do not expect this to be a major omission because our search strategy did identify one study that used the ASE model[41] and another that applied a refined Ecological model,[24] which are uncommon in the general literature. It is acknowledged that a recent review of behavioural research in the broader injury prevention context[17] identified a larger range of theory applications (e.g. Health Belief model, Theory of Reasoned Action/Theory of Planned Behaviour, Social Cognitive Theory, Diffusion of Innovations, PRECEDE-PROCEED and Social Marketing Theory) than we were able to find in the sports injury prevention literature. Moreover, although excluded from this review, there is recognized use of BSSTM in studies of bicycle helmets and bicycle safety (see references[152-154] for examples).

Our process of searching, which included hand searching reference lists and additional author searches, did identify further studies and point to the problem of how articles are indexed in databases. We excluded non-peer-reviewed (grey) literature, such as conference proceedings and dissertations, and this may have limited the identification of theory applications in sport injury prevention contexts, though we consider this unlikely. It is possible that some authors of peer-reviewed studies are not reporting full details of their use of BSSTM due to factors such as length restrictions applied by journals. If this were the case, then the number (and proportion) of papers we assigned to the atheoretical categories of BSSTM use may be overestimated. If the field is to progress and researchers are to benefit from the accumulated wisdom of others, it would be pertinent for authors to include these details in their papers and for journal editors to require it formally. Without this, it is likely that researchers will continue to make the same 'mistakes' resulting in critical components of interventions, their target behavioural variables and maximal implementation strategies not being identified.

The initial search for articles relied on abstract content only; it was, however, apparent that some studies seemed to have a behavioural approach (i.e. implementing an exercise programme) and did not clearly link to the stated exclusion criteria in the first instance. A full-text review of these 'unclear exclusion' studies was undertaken. None of the unclear exclusion studies mentioned theory applications; however, some did mention outcome measures (e.g. attitude, knowledge and behaviour) in the method/discussion section and, subsequently, were included in the review (see Braham et al.[35] for example).

4.2 Implications for Future Research

The lack of evidence supporting the widespread use of BSSTM in the design, implementation and evaluation of sports injury interventions results in difficulty providing clear direction or strategies to enhance uptake of sport injury prevention interventions. Unfortunately, the current status of the field also does not appear to assist in enhancing theory development in sport injury prevention research. Previous reviews of sports injury studies have also noted many problems with the quality of their research designs[15] and until these are addressed uniformly, this may have implications for sports injury prevention. Having said this, whether the application of BSSTM to sport injury prevention contexts will improve the uptake of sport injury interventions is largely unanswered, but the evidence from other areas of public health priority suggests it should play a key role. To date, very few studies have used BSSTM; when applied, their use has been varied, with no studies being undertaken in the same sporting setting to enable comparisons of theories or consistency of findings to be established.

Extending current work to the evaluation of the robustness of behavioural findings when theory is applied to particular sport injury prevention issues, and determination of what theories and models work best for specific sport injury prevention topics is needed. It is recommended that further research be conducted to compare or even integrate theories, so that the safety recommendations arising from future research studies take into account the complexity of sports behaviours and settings and the multitude of factors contributing to injury risk. It is unlikely that a single theory will be shown to explain the dynamics of safety behaviours in sporting contexts fully. Rather, it is likely that existing theories will need to be extended or refined to incorporate multi-level approaches. The extended ecological model of Eime et al.[24] is one step in this direction.

Finally, given the widespread use of BSSTM in other application areas (such as exercise promotion, occupational safety and road safety) valuable lessons could be synthesized and translated to the sport injury prevention area to reduce investment in unnecessary and costly duplication of efforts. Importantly, the sports injury prevention research field needs to embrace interdisciplinary collaborations and partnerships. This will enhance the applicability and relevance of research programmes to real-world safety applications and contexts (and vice versa). Significant injury reductions will only be achieved at a population level if research efforts contribute to collectively changing individual behaviours, environmental conditions and social structures to develop supportive safe sports contexts.[12,13]

5. Conclusions

This review has highlighted the general lack of use of BSSTM in studies relating to unintentional sport injury prevention research. Future research in this area, incorporating such approaches is needed in studies that are rigorously designed and analysed. It will also be important to interweave BSSTM approaches into the mainstream of sport injury prevention research, through increasing multidisciplinary/interdisciplinary research teams. There already exist a number of BSSTM applications that researchers could use in enhancing the uptake of sport injury prevention measures, and new behaviour change theories and models are constantly emerging.[135] The field needs researchers who are willing to put these theories to the test. Advances in BSSTM development, as well as increased attention to behaviour change research, will provide new opportunities for reducing injuries and enhancing the uptake of preventive measures. By combining the usual sports injury prevention methods with BSSTM, the field will obtain a better understanding of how and why sports participants (and the settings they play in) make safety-related decisions and what enhancements can be made to injury prevention strategies to ensure their sustained uptake. As Trifiletti et al.[17] posits "It will take creative researchers to find the nexus" (page 305).

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Sports Medicine

The Extent to Which Behavioural and Social Sciences Theories and Models are Used in Sport Injury Prevention Research

A.J. McGlashan and C.F. Finch

Supplemental Digital Content

This Supplemental Digital Content contains the appendix referred to in the full version of this article, which can be found at http://adisonline.com/sportsmedicine

APPENDIX 1

EXCLUDED STUDIES (n=110)
Studies not meeting full inclusion/exclusion criteria

Protective Equipment (n=41)

PPE- Eyewear (n=2)

Eime R, Finch C, Owen N, et al. Do squash players accurately report use of appropriate protective eyewear? Journal of Science and Medicine in Sport 2005; 8(3): 352-356.
Oberholzer AD, Ferreira JT. The use of protective eyewear in the game of squash. The South African Optometrist 2003; 62(4): 159-165.

PPE- Headgear (n=9)

Alexander MH, Raub J. How to protect your "coconut": a safety demonstration on the importance of wearing a ski helmet. Journal of Emergency Nursing 2003; 29(5):461-2.
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Jones SJ, et al. Effectiveness of rugby headgear in preventing soft tissue injuries to the head: a case-control and video cohort study. Br J Sports Med 2004; 38: 159-162.
Kaut KP, DePompei R., Kerr J, et al. Reports of head injury and symptom knowledge among college athletes: implications for assessment and educational intervention. Clin J Sports Med 2003; 13(4):213-21.
McIntosh AS, Janda D. Evaluation of cricket helmet performance and comparison with baseball and ice hockey helmets. Br J Sports Med 2003; 37(4):325-30.
McIntosh A, McCrory P. Effectiveness of headgear in a pilot study of under 15 rugby union football. Br J Sports Med 2001; 35: 167-169.
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Wu BC, Oakes JM. A randomized controlled trial of sport helmet interventions in a paediatric emergency department. Pediat Emer Care 2005; 21 11:730-5.

PPE- Mouthguards (n=11)

Banky J. McCrory PR. Mouthguard use in Australian football. J Sci Med Sport 1999; 2 1; 20-29.
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Jalleh G, Donovan RJ, Clarkson J, et al. Increasing mouthguard usage among junior rugby and basketball players. Aust NZ J Pub Health 2001; 25(3): 250-252.
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Lieger O, von AT. Orofacial / cerebral injuries and the use of mouthguards by professional athletes in Switzerland. Dental Traumatology 2006; 22 (1):1-6.
Mihalik JP, et al. Effectiveness of mouthguards in reducing neurocognitive deficits following sports-related cerebral concussion. Dental Traumatology 2007;23 1:14-20.
Onyeaso CO, Adegbesan OA. Oro-facial injury and mouthguard usage by athletes in Nigeria. Int Dent J 2003;53 4: 231-236.
Sherker S, Cassell E. Personal protective equipment use by in-line skaters in Victoria. Australia and New Zealand Journal of Public Health 2001; 25(2): 179-184.
Tulunoglu I, Ozbek M. Oral trauma, mouthguard awareness, and use in two contact sports in Turkey. Dental Traumatology 2006; 22 5: 242-246.

PPE- Face-Guard (n=1)

Benson BW, Mohtadi NG, Rose MS, et al. Head and neck injuries among ice hockey players wearing full face shields vs half face shields. JAMA 1999; 282: 2328–2332

PPE- Harness (n=1)

Wallis R, Elliott B, Koh M. The effect of a fast bowling harness in cricket: an intervention study. J Sports Sci 2002; 20: 495-506.

PPE- Ski-Bindings (n=1)

Finch CF, Kelsall HL. The effectiveness of ski bindings and their professional adjustment for preventing alpine skiing injuries. Sports Med. 1998; 25(6):407–416.

PPE – Thermal Pants (n=1)

Upton PAH, Noakes TD, Juritz JM. Thermal pants may reduce the risk of recurrent hamstring injuries in rugby players. Br J Sports Med 1996; 30(1): 57-60.

PPE- Footwear (n=1)

Barrett JR, Tanji JL, Drake C, et al. High- versus low-top shoes for the prevention of ankle sprains in basketball players: a prospective randomized study. Am J Sports Med 1993; 21 (4): 582-585.

PPE- Prophylaxis (n=3)

Eckstramd J, et al. Prevention of soccer injuries: supervision by doctor and physiotherapist. Am J Sports Med 1983; 11(3): 116-120.

Heiser TM, Weber J, Sullivan G, et al. Prophylaxis and management of hamstring injuries in intercollegiate football players. Am J Sports Med 1984;12:368-369.

Moiler K, Hall T, Robinson K. The role of fibular tape in the prevention of ankle injury in basketball: a pilot study. J Orthop Sports Phys Ther 2006; 36 9: 661-668.

PPE- Regulation (n=1)

Marshall SW, et al. An ecologic study of protective equipment and injury in two contact sports. Int J Epidemio 2002;31:587-592.

PPE- General (n=5)

Ceroni D, De R, Kaelin, A. The importance of proper shoe gear and safety stirrups in the prevention of equestrian foot injuries. Journal of Foot & Ankle Surgery 2007; 46(1):32-9.

Marshall SW, Loomis DP, Waller AE, et al. Evaluation of protective equipment for prevention of injuries in rugby union. International Journal of Epidemiology 2004; 34(1): 113-118.

Osberg JS, Stiles SC. Safety behaviour of in-line skaters. Inj Prev 2000; 6: 229-231.

Schieber RA, Branche-Dorsey CM, Ryan GW, et al. Risk factors for injuries from in-line skating and the effectiveness of safety gear. New England Journal of Medicine 1996; 335 (22): 1630–1635.

Yang J, Marshall SW, Bowling JM, et al.. Use of discretionary protective equipment and rate of lower extremity injury in high school athletes. American Journal of Epidemiology 2005; 161: 511-519.

PE- Sliding Bases (n=5)

Janda DH, Mackesy D, Maguire R, et al. Sliding-associated injuries in college and professional baseball — 1990–1991. Morbidity & Mortality Weekly Report 1993;, 42 (12): 229–230

Janda DH, Wojtys EM, Hankin FM, et al. Softball sliding injuries: a prospective study comparing standard and modified bases. Journal of the American Medical Association 1988; 259: 1848–1850

Janda DH, Bir C, Kendroske B. A comparison of standard versus breakaway bases: an analysis of a preventative intervention for softball and baseball. Foot Ank Int 2001; 22; 810-816.

Sendre RA, Keating TM, Hornak JE, et al. Use of the hollywood impact base and standard stationary base to reduce sliding and base-running injuries in baseball and softball. American Journal of Sports Medicine1994; 22: 450–453

Richter M. Re: A laboratory analysis of a preventative intervention for softball and baseball: standard vs. break-away bases, Janda DH, et al., Foot Ankle Int. 22 10:810-816, 2001.[comment]. Foot & Ankle International 2003; 24 8: 657; author reply 657-8.

Education (n=2)

Elliott B, Khangure M. Disk degeneration and fast bowling in cricket: an intervention study. Med Sci Sports Exerc 2002;34 11:1714-8.

Arnason A, Engebretsen L, Bahr . No effect of a video-based awareness program on the rate of soccer injuries. Am J Sports Med 2005; 33(1): 77-84.

Specialised Exercise (n=67)

Arnanson A, Andersen TE, Holme I, et al. Prevention of hamstring strains in elite soccer: an

intervention study. Scan J Med Sci Sports 2007; doi:10.1111/j.1600-0838
Askling C, Karlsson A, Thorstensson A. Hamstring injury occurrence in elite soccer players after preseason strength training with eccentric overload. Scand J of Med Sci Sports 2003; 13:244-250.
Bahr RL, Bahr IA. A twofold reduction in the incidence of acute ankle sprains in volleyball after the introduction of an injury prevention program: a prospective cohort study. Scandinavian Journal of Medicine and Science in Sports 1997; 7:172-177.
Bencke J, Naesborg H, Simonsen EB, et al. Motor pattern of the knee joint muscles during side-step cutting in European team handball: influences on muscular co-ordination after an intervention study. Scand J Med Sci Sports 2000; 10; 68-77.
Bixler B, Jones RL. High-school football injuries: effects of a post-halftime warm-up and stretching routine. Fam Pract Res J 1992;12 2:131-139.
Blitvich JD, McElroy GK, Blanksby BA, et al. Long term retention of safe diving skills. J Sci Med Sport 2003;6 3:348-354.
Brooks JHM, Fuller CW, Kemp SPT, et al. Incidence, risk, and prevention of hamstring muscle injuries in professional rugby union. Am J Sports Med 2006; 34:1297-1306.
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Caraffa A, Cerulli G, Projetti M, et al. Prevention of anterior cruciate ligament injuries in soccer: A prospective controlled study of proprioceptive training. Knee Surgery, Sports Traumatology and Arthroscopy 1996; 4:19
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Croisier JL, Ganteaume S, Binet J, et al. Strength imbalances and prevention of hamstring injury in professional soccer players. American Journal of Sports Medicine 2008; 36(8): 1469-1475.
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Elphinston J, Hardman, SL. Effect of an integrated functional stability program on injury rates in an international netball squad. J Sci Med Sport 2006; 9 1-2:169-76.
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Garrick JG, Requa R. Structured exercise to prevent lower limb injuries in young handball players. Clin J Sport Med 2005;15 5:398-405.
Heidt RS, Sweeterman LM, Carlonas, RL, et al. Avoidance of soccer injuries with preseason conditioning. American Journal of Sports Medicine 2000; 28: 659-662.

Hewett T, Stroupe A, Nance T, et al. Plyometric training in female athletes. Am J Sports Med 1996; 24: 427-436.
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Appendix E: Summary of BSSTM in Sport Injury Prevention Research

Reference	BSSTM used	Trifiletti BSSTM Application	Population	Target Behaviour	Study Design	Findings	Study Recommendations	Limitations
Williams-Avery et al, (1996)	HBM	3	In-line skaters College Students Arizona, USA n=217	PPE-General	Cross-sectional	Significant predictors of PPE use and freq. of PPE use: PBar, PSus, PBen and PSev Most significant predictor was PBar, followed by PSus PSev was the construct least associated with PPE worn and the freq. of PPE use	Methods to reduce PBar and increase PSus to injury are needed, in addition to making the social normative climate more conducive to wearing PPE.	Cross-sectional precluding causal conclusions. Limitation in generalisation of findings -socio-demographic -sample size. Validity/reliability issues - Potential errors in operationalisation of constructs. Cue to action and SE. Implications of findings lacking.
Rosen et al., (1982)	TRA	1,2, 3	Skiing Adult/non-specific Vermont, USA n=160	PPE- Ski Bindings	Cross-sectional -including elicitation interviews	<u>Behaviour</u> >50% (n=89 skiers) obtained professional binding adjustment 129 skiers reported that they had completed binding adjustment themselves, with 31 skiers stating they did not self-adjust bindings <u>Attitude Toward the Behaviour</u> Skiers more likely to have their bindings adjusted if they believed that negative outcomes could be avoided (e.g. prevent a ski injury and prevent an inadvertent release) with properly adjusted bindings <u>Subjective Norm</u> Skiers more likely to have their bindings adjusted if they thought that knowledgeable individuals would favour taking this action	May be necessary to provide skiers with more factual information about the relationship between release settings and ski accidents. May be possible to increase the rate of professional binding adjustment and decrease the rate of self-adjustment if respected groups within the ski community such as ski shop personnel, ski magazine writers, ski area operators, and medical personnel promoted proper binding care more rigorously.	Cross-sectional precluding causal conclusions. Did not explicitly specific attitudes and subjective norms related to adjustment binding "cognitive structure". Did not establish consistency between behavioural intentions and actual behaviour. Limitation in generalisation of findings -socio-demographic -sample size. Limited items to measure constructs. The limited detail of the elicitation interviews. Implication of findings lacking.

Reference	BSSTM used	Trifiletti BSSTM Application	Population	Target Behaviour	Study Design	Findings	Study Recommendations	Limitations
Deroche et al., (2009)	TPB + PSus/ PSev	1,2, 3	In-line skating Adult/non-specific France n= 181	PPE - General	Cross-sectional	Instrumental attitude and subjective norm Instrumental attitude has a much stronger relationship to PPE wearing intention than emotional attitude Subjective norms were less influential on skaters intentions to wear PPE than instrumental attitude Similarly, PBC was not linked to PPE wearing intentions among adults when it considered other TPB variables PSus/PSev added a small but incremental portion of variance in the prediction of PPE wearing intentions Subjective norms did not remain significant in predicting skater intentions to wear PPE when PSus/PSev were added in the regression analysis, thus “personal consideration” appeared to be more important than “perceived social pressure”	Targeting an adult population intervention should attempt to focus on: TPB components, especially instrumental attitudes (i.e. it would be useful to wear PPE while skating) toward PPE . Increase the strength of beliefs, such as perceived risk of severe injury, to promote preventive behaviours.	Cross-sectional precluding causal conclusions. No elicitation phase being conducted. Limitation in generalisation of findings -socio-demographic -sample size. Limited items to measure constructs.
Finch et al, (2003)	TPB	1, 2	Australian football Elite junior Players n=103	General Injury Prevention	Cross-sectional	6% of players believed it was safe to play with injuries and 58% reported they would be willing to do so >80% of players reported they would risk playing with an injury if they thought their chances of being selected in the AFL draft would be affected if they did not play 70% of players believed injured players would likely suffer later problems if they continued to play with injuries Local club coaches were perceived by players to provide significant more support to injured players than VFL U18 coaches or school coaches Administrators at VFL U18 level were however perceived to be more supportive than club level administrators Support from team mates when a player was injured was shown to be lower at school than VFL U18 or club level The level of support from family was perceived to be high in all settings	Negative attitudes and beliefs should be addressed in any comprehensive injury prevention strategy aimed at the elite junior players	Cross-sectional precluding causal conclusions. Used theory as a “loose framework” . No elicitation phase conducted. Issues with validity/reliability -potential errors in operationalisation of constructs. Limitation in generalisation of findings -socio-demographic -sample size. Did not link findings explicitly with construct. Implication of findings lacking.

Reference	BSSTM used	Trifiletti BSSTM Application	Population	Target Behaviour	Study Design	Findings	Study Recommendations	Limitations
						Many players reported that they felt pressured to play when injured; this was particular associated with school football Feelings of isolation were reported by players when injured, particularly at the VFL level Across all settings most players also reported not being included in club activities when injured		
Iversen et al, (2008)	TRA/ TPB	2	Basketball High School Varsity/ Junior Varsity Division III Massachusetts South Coast Conference Players (female) + Coaches USA n=130 players n= 12 coaches	Multi Intervention (SEE)	Intervention Prospective pre-post	<u>Overall</u> Use of education principles and skills promoted in program effective in being readily integrated into practice drills Training program was readily embraced by coaches and players and it did not prove to be problematic for coaches to implement Coaches were a key factor in reinforcing injury prevention principles throughout the season <u>Players</u> Players' average scores on baseline knowledge regarding knee anatomy and function of the ACL was 57.3% No significant difference between players with a prior knee injury and those that had no prior knee injury Players has positive attitudes towards the use of ACL injury prevention techniques Average >50% used ACL injury practices Video analysis of landing techniques indicated that the 48% of players demonstrated proper two-footed flexed knee landing techniques <u>Coaches</u> Coaches, at baseline, scored an average of 68.8 on the knowledge scale and demonstrated positive attitudes towards ACL injury prevention techniques (mean score 85.6)		Used theory as a "loose framework". Did not link findings explicitly with construct. Issues with validity/reliability -potential errors in operationalisation of constructs. No elicitation phase conducted, as per TPB questionnaire guidelines. Use of no control group leading to the potential for type II error. Program development issues -intervention being limited over a period of 8 weeks. Implementation and disseminations issues -Details about implementation components and issues were not reported -did not appear to be formally evaluated -Did not explicitly mention behaviour change strategies which appeared to be modelling, observation, stimulus control and reinforcement.

Reference	BSSTM used	Trifiletti BSSTM Application	Population	Target Behaviour	Study Design	Findings	Study Recommendations	Limitations
						Average self-reported use of injury prevention practices during training was 61.1 (range 41.4-97.0) Knowledge about the ACL and risk factors for ACL injury ↑ at post- test assessment, however there were no significant corresponding changes in attitudes toward injury risk or self-report preventive practices Observed use of two-footed flexed knee landing during the game improved during the study, however there was not a strong correlation of self-report use of preventive practices and observed use Results also indicated that changes in knowledge, attitudes and practice varied by school Coaches ACL knowledge linked to more favourable attitudes toward ACL injury prevention techniques and practices. Their players also scored higher, on average, on the post-test assessment		Limitation in generalisation of findings -socio-demographic -sample size. Implication of findings lacking.
De Nooijer et al., (2004)	ASE Model	1, 3	In-line skating Junior/ Children recreational to high performance Age 9-13 years Netherlands n=1200	PPE-General	Cross-sectional	PPE was not often used (36% used wrist guards, 28% used kneepads, 14% used elbow pads, and 5% used helmets) No differences found between male and female students using PPE, with the exception of females generally using wrist guards more so than males Significant predictors of PPE use included: social influences (modelling and social pressure), self-efficacy expectations and intention Age and freq. also accounted for 5% of the variance in relation to PPE use	Educating children about the risks of skating, the benefits of using PPE and about how to manage barriers that may interfere with PPE use. Facilitating automatic or habitual use of PPE. Making PPE mandatory during competitions, organised skate tours or playground's near school shop's that sell in-line skates. Facilitating the purchase of PPE with in-line skates. Manufacturers of PPE developing comfortable and attractive helmets and other equipment.	Cross-sectional precluding causal conclusions. Limitation in generalisation of findings -socio-demographic. Implication of findings lacking -Recommended strategies were not solely based on findings related to this study.

Reference	BSSTM used	Trifiletti BSSTM Application	Population	Target Behaviour	Study Design	Findings	Study Recommendations	Limitations
Yang et al, (2005)	SCT	1, 2	Various Sports (12 sports) Junior Athletes + Coaches/ High School USA n=13513 athletes n=609 coaches	PPE-General	Cross-sectional	Significant predictors of PPE use included: small school size (physical environment factors), low player/coach ratio (social environmental factors), high PPE usage by team mates (observational learning factors), and a history of prior injury (proxy-behavioural capability factors). Coach factors such as experience, qualifications and training were not significant predictors of PPE use .	Intervention efforts to promote the use of protective equipment need to target school-level factors and involve peer influence.	Cross-sectional precluding causal conclusions. Limitation in generalisation of findings -socio-demographic Issues with validity/reliability -potential errors in operationalisation of constructs. Implication of findings lacking.
Sawyer et al, (2008)	DIT	1, 2	Various sports Adolescent/ High School Athletic Coaches USA n=497	Education Intervention	Cross-sectional	Most coaches reported that they had used or planned to use the toolkit materials. Most (81%) in schools with a written plan for preventing and managing concussions indicated that the toolkit could be used to improve it. 96% of coaches in schools without a plan indicated that the kit could be used to develop one. Most assessed the kit as visually appealing, easy to use, and contained appropriate content. There were no significant differences among coaches with differing professional experience or for sports with different injury rates. Among the coaches with other concussion prevention materials, most indicated greater satisfaction with the toolkit.		Participation and low response rates potentially affecting external validity. Program implementation. Lack of/or no clarity around the specifics of concepts and stages in the diffusion process and important factors in the diffusion process.
Andersen et al, (2004)	DIT	4	Skiing and Snowboarding Adult/non-specific USA n=	PPE-Headgear	Cross-sectional Observationa l	Helmet use by skiers and snowboarders increased and was most prevalent among snowboarders, experts and more frequent skiers/snowboarders. Adoption rates were becoming wide spread among beginners. Although the critical mass hypothesis (as stated in the DIT) was not supported, media	Longitudinal follow up may be required to test the critical mass hypothesis further.	Challenges involved in planning for program dissemination.

Reference	BSSTM used	Trifiletti BSSTM Application	Population	Target Behaviour	Study Design	Findings	Study Recommendations	Limitations
						coverage and marketing campaigns on helmets may have contributed to the upward trend in helmet usage amongst all skiers.		
Simpson et al, (2002)	PP + OC	1,2,4	Rugby Union Population wide New Zealand n=unspecified	Multi-Intervention	Conceptual Development	Design of program relied heavily on a collaborative, multi-disciplinary panel that included key members of the Rugby union community. Design and development based on preliminary research findings of risk and protective factors identified in a New Zealand Rugby study. Discussion among these key stakeholders revolved around identification of risk or protective factors, these included incidence of injury increasing with increasing grade of play, more than 1/3 of injuries in games were contact-occurring during a tackle or attempted tackle, head and face injuries occurring as a result of foul play, endurance training during off-season indicating a decrease in injury, prior injury increasing the risk of injury during the season, and alcohol-related behaviour being a major issue. Application of the PRECEDE-PROCEED assisted identify predisposing (beliefs, attitudes, values and perceived needs that support action in the future), enabling (conditions of the environment, actions by others or access to resources that make action possible) and reinforcing (ongoing rewards for a particular behaviour) factors for playing after injury. The Ottawa Charter was used to identify strategies to reduce foul play and encouraged alternative strategies addressing expectations of fair play, personal skills and quality of refereeing, official support for referees' decisions, and the recruitment and retention of referees.	Advocated for a multi-dimensional approach to developing an injury prevention program and acknowledge the complexity of reducing injury within a sporting context.	Were not specific about the intended audience during the planning process. Lack discussion if or how they have integrated social and behavioural theory with the models constructs. Do not specify intervention development and methods in detail.
Eime et al, (2004)	EcoM	1,4	Squash Non-specific Players + Venue Managers	PPE-Eyewear	Conceptual Development	<u>Players</u> 17% wore PPE-eyewear whilst playing squash.	The strong collaborative nature of this project involving the Victorian Squash Federation as the relevant sporting body, the	Appeared to use HBM and TTM concepts, however did not explicitly state these theories.

Reference	BSSTM used	Trifiletti BSSTM Application	Population	Target Behaviour	Study Design	Findings	Study Recommendations	Limitations
			n= 1163 players n= venue managers			8% of players indicated that they wore the correct/most appropriate PPE-eyewear - polycarbonate lenses. 74% of players indicated they had never attempted to wear polycarbonate lenses. Common reasons for use of PPE-eyewear included: Players' knowledge of the risk of eye injury (53%) Previous eye injury experience (28%) Knowing someone who has had an eye injury (37%) Common reasons for non-use included: PPE-eyewear being uncomfortable/restricting vision (51%) They did not want to (31%) They never thought about it (26%) Belief that PPE-eyewear was not necessary (22%) <u>Venue Managers (VM)</u> Availability of PPE eyewear at these venues for players to borrow/hire and/or purchase was lacking. VM lacked knowledge or felt uncertain about the type of suitable PPE-eyewear to have available and where they could obtain it. VM did not play an active role in promoting the use of PPE-eyewear. VM Favourable towards obtaining education about eye injuries and PPE and taking a more active role in promoting safety behaviour. VM expressed concern about their ability to enforce a protective eyewear regulation and many anticipated negative reactions from players. <u>Design of PEP</u> Results of baseline player surveys and venue manager interviews were used to assist in the development of the PEP strategy	venue manager and players, as well as the PPE manufacturers in this project provides a model approach to sports injury prevention research.	Implementation and disseminations issues -Details about implementation components and issues were not reported. Stated mention some behavioural strategies used e.g. posters (cures to action), however it was unclear how some strategies were applied. Unclear what the policies and physical environmental influences of PPE-eyewear use were. Cross-sectional precluding causal conclusions.

Reference	BSSTM used	Trifiletti BSSTM Application	Population	Target Behaviour	Study Design	Findings	Study Recommendations	Limitations
						The main components of the PEP involved providing information and education to both players and squash venue operators about the risk of eye injury and of appropriate protective eyewear, as well as assisting with the availability of the eyewear and offering incentives for players to use it. Attempts were made within the project structure to make provision for the future dissemination and sustainability of more widespread eye injury prevention measures in the sport of squash.		
Glang et al., (2010)	SCT + HBM + TRA	1 Conceptual framework underlying intervention HBM + TRA Evaluation SCT + HBM + TRA	Various Sports (unspecified) Coaches USA n=75	Coach Education Intervention	Intervention RCT Surveys	Coaches who viewed the ACTive program (intervention) showed significantly greater improvement than those who viewed CDC safety materials (control) in: -knowledge about sport concussion, management and prevention -attitudes about the importance of preventing sports concussion -intention and self-efficacy in sports concussion management and prevention	Future studies could examine the durability of findings and identify whether changes in knowledge, attitude, self-efficacy and intention maintain overtime Expanding measures to include behavioural assessments would yield important information about skill application in real-life contexts E-learning is a promising approach for providing training in the management of concussion in practice and game situations to coaches Used in conjunction with education for athletes and the larger athletic and school community (e.g. parents, teachers, and school administrators), this training has the potential to minimise the risks associated with sports concussion in youth and high school athletes.	Limitation in generalisation of findings -socio-demographic -sample size External validity limited -fairly homogeneous sample in terms of ethnocultural diversity Majority of coaches were well educated

Reference	BSSTM used	Trifiletti BSSTM Application	Population	Target Behaviour	Study Design	Findings	Study Recommendations	Limitations
Saunders et al., (2010) #	RE-AIM	1	31 community junior netball coaches	SET coaches' feedback on the implementation of an evidence-informed injury prevention programme in community junior netball using coaches' perceptions and the RE–AIM framework	A lower-limb injury prevention programme (Down to Earth; D2E), for teaching safe-landing techniques, was delivered to 31 coaches from 31 junior community netball teams in a 1-h workshop. Coaches then delivered a 6-week programme at team training sessions starting in the week before the competition season commenced. 65% of coaches completed a feedback survey 17 weeks after they had delivered the programme	Most (88%) coaches believed that D2E improved their players' ability to perform correct landing techniques in games and that players had retained these improvements over the season. The majority (83%) indicated that an improvement in player athletic attributes was the greatest advantage of D2E, followed by a reduction in injury risk. Identified barriers to implementing D2E were running out of time and very young players finding the drills too difficult. Coaches reported that they needed more ideas for training drills that could be incorporated into their programmes and believed that their own coaching training did not adequately prepare them to implement an injury prevention programme	Although coaches believed that D2E was effective in developing correct landing techniques, some modifications are needed to make it more suitable for younger players and coach education by accreditation courses could be improved to support the implementation of injury prevention programmes. It would be worthwhile to reassess the retention of coaches' knowledge and beliefs of D2E principles with an extended follow-up (eg, into the next season).	Authors indicated Although this study was restricted to one netball association, and on a relatively small sample of coaches, there is no reason to believe that the issues raised would be very different to those raised by junior coaches elsewhere.
Chan et al, (2012) #	SDT	3	Elite athletes (Study 1: N=214; Study 2: N=533) completed the	General – sport injury prevention behaviours (incl.	cross-sectional survey	Partial least squares path analytic models indicated acceptable fit of the hypothesised model in all samples, and consistently found in both studies that autonomous motivation from SDT was positively associated with	Motivational regulations from SDT might serve as sources of information that influence athletes' intentions through their	-

Reference	BSSTM used	Trifiletti BSSTM Application	Population	Target Behaviour	Study Design	Findings	Study Recommendations	Limitations
			Treatment Self-Regulation Questionnaire and psychometric measures of constructs from the TPB, with respect to their rehabilitation from sport injury in a hypothetical scenario (Study 1), or their injury prevention experiences (Study 2)	rehabilitation)		attitudes, subjective norms and perceived behavioural control from the TPB, and these three TPB variables positively predicted intentions of injury rehabilitation and prevention. Controlled motivation from SDT was, unexpectedly, positively linked to intentions, but the effect was smaller than that for autonomous motivation.	impact on the attitude, perceived social norm and controllability of injury rehabilitation and prevention.	
Chan et al, (2012) #	SDT; Trans-contextual process	3	Elite athletes (N = 533) completed self-report measures of the predictors (Week 1) and the dependent variables (Week 2).	examined whether general causality orientation, perceived autonomy support from coaches (PAS), self-determined motivation (SD-Mtv), and basic need satisfaction in a sport context predicted SD-Mtv, beliefs, and adherence with respect to sport injury prevention	surveys	Variance-based structural equation modeling supported hypotheses: SD-Mtv in a sport context was significantly predicted by PAS and basic need satisfaction and was positively associated with SD-Mtv for sport injury prevention when controlling for general causality orientation. SD-Mtv for sport injury prevention was a significant predictor of adherence to injury-preventive behaviors and beliefs regarding safety in sport.	The transcontextual mechanism of motivation may explain the process by which distal motivational factors in sport direct the formation of proximal motivation, beliefs, and behaviors of sport injury prevention.	-

Reference	BSSTM used	Trifiletti BSSTM Application	Population	Target Behaviour	Study Design	Findings	Study Recommendations	Limitations
Chrisma et al., (2013) #	TPB	1	Soccer Varsity High School n= 50 players (2 boys and 4 girls teams)	Concussion symptom reporting	Qual focus groups 2010-2011	Athletes could describe multiple signs and symptoms of concussion. Athletes also understand the dangers of concussions, and all groups mentioned the possibility of death or long term disability. However, when confronted with scenarios involving symptom, athletes reported they would not stop playing. They would either continue to play (6/9 groups) or would take a brief break and then return to play (3/9 groups). Several barriers seemed to explain athletes' responses. Athletes wanted to keep playing and knew that reporting symptoms might result in being removed from the game. In addition, concussive symptoms were nonspecific, and thus could be mistaken of another etiology. Finally athletes were hesitant to report symptoms to coaches if they did not result in any significant pain or disability.	Interventions that seek to improve coach communication with athletes regarding concussion management might increase symptom reporting.	Limitation in generalisation of findings -No random sampling Recent law changes (Lystedt Law), not known what impact this may have had on athletes Use of focus groups may have impacted athlete views because of team dynamics, however it was deemed this was appropriate to reflect the usual context in which athletes make reporting decisions.
Donaldson et al., (2014) #	IM	1	Community rugby coaches in regional New South Wales, Australia.	Neck-injury prevention program – Mayday Safety Procedure (potentially dangerous scrum situations)	Step 5 of intervention mapping was used to plan strategies to enhance MSP adoption and implementation	Coaches were identified as the primary MSP adopters and implementers within a system including administrators, players and referees. A local advisory group was established to ensure context relevance. Performance objectives (eg, attend MSP training for coaches) and determinants of adoption and implementation behaviour (eg, knowledge, beliefs, skills and environment) were identified, informed by Social Cognitive Theory. Adoption and implementation matrices were developed and change-objectives for coaches were identified (eg, skills to deliver MSP training to players). Finally, intervention methods and specific strategies (eg, coach education, social marketing and policy and by-law development) were identified based on advisory group member experience, evidence of effective coach safety behaviour-change interventions and Diffusion of Innovations theory.	This is the first published example of a systematic approach to plan injury prevention programme diffusion in community sports. The key strengths of this approach were an effective researcher–practitioner partnership; actively engaging local sports administrators; targeting specific behaviour determinants, informed by theory and evidence; and taking context-related practical strengths and constraints into consideration. It was mentioned evaluation of the outcome of implementing this diffusion plan in a single region during the 2011 rugby season to see if investment in the strategic	The major challenges were the time involved in using a systematic diffusion planning approach for the first time; and finding a planning language that was acceptable and meaningful to researchers and practitioners.

Reference	BSSTM used	Trifiletti BSSTM Application	Population	Target Behaviour	Study Design	Findings	Study Recommendations	Limitations
							planning process for diffusion of the MSP was warranted.	
White et al., (2014) #	TPB	1.3	51 Junior community netball coaches from 2 netball associations in Victoria, Australia	SET- coaches teaching of correct landing technique	Cross-sectional survey	Overall >94% of coaches had strong positive attitudes towards toward teaching correct landing technique and >80% had strong positive perceptions of their own control over delivery of such programs. Coaches' ratings of social norms relating what others think about teaching safe landing technique were more positive (>94%) than those relating to what others do (63-74%).	Junior coaches are generally receptive toward delivery safe landing training programs in the training sessions they led. Future coach education and opportunities for communication for communication between coaches about what they are/are not doing could include role modelling by prominent coaches so that more community-level coaches are aware that this is a behaviour that many coaches can, and do, engage in. Although sporting bodies can place expectations on coaches to deliver safety programs in their training sessions, coaches' actual actions may depend on how competent they believe they are to do so. Coach education that provides the skills/strategies necessary to implement these programs, including how to generate and maintain player motivation, could assist with this.	Sample size was relatively small and it is not known how representative of other junior netball coaches the survey sampled was. Did not collect information about other factors that could influence coaches' views (e.g., experiences with injured athletes, previous engagement in delivering safety programs)
Newton et al, (2014) #	TPB (extended)	1,3	183 AF coaches, 121 AF trainers, 171 RL coaches, 142 rugby RL sport trainers	Intention to use concussion guidelines	Cross-sectional survey	Personal norms and self-efficacy were significant predictors of intention to use concussion guidelines, although the relationship between self-efficacy and intention was stronger among AF coaches than RL coaches. Analysis of the salient beliefs that underpin self-efficacy found that	Programmes aimed at increasing the intended use of sports concussion guidelines should focus on enhancing self-efficacy and leveraging personal norms. Increasing coaches'	participants were not randomly recruited but were instead those who had responded to a widely disseminated study invitation notice. This might limit the extent to

Reference	BSSTM used	Trifiletti BSSTM Application	Population	Target Behaviour	Study Design	Findings	Study Recommendations	Limitations
						coaches, irrespective of football code, felt less familiar and less experienced than sport trainers in using the concussion guidelines. At the same time, AF personnel, irrespective of their team role, felt that they had insufficient time and resources to implement the concussion guidelines relative to rugby personnel.	familiarity and experience in using the concussion guidelines would also be warranted, as would finding ways to overcome the perceived time and resource constraints identified among Australian football personnel.	which the results can be generalied to the broader population of AF and RL coaches and sport trainers as it is not known how representative of the broader population the respondents were. Nevertheless, the sample was sufficiently large to minimise the extent of such biases. The outcome variable examined in this study was a measure of intention, not behaviour. Intention is a central construct in decision-making and one that is worthy of examination in its own right. Not all individual with a positive intention to perform a particular behaviour will go on to enact the behaviour and future use would need to be evaluated.
Kroshus et al, (2014) #	TPB	1	146 players and 6 male collegiate ice hockey teams in one Division 1 conference	Concussion education	Prospective cohort study, before and after surveys	All teams received concussion education material; however, content and delivery varied. Rates of material recall differed by delivery format. Considering all teams together, there were no significant improvements in knowledge and only a very small decrease in intention to continue playing while experiencing symptoms of a concussion. Pre-education and post-education, there were significant between-team differences in attitudes towards concussion reporting and behavioural intention.	Future research with larger samples is encouraged to evaluate the content and effectiveness of existing concussion education in other sporting populations. Future evaluation efforts include longer-term behavioural follow-up and test whether behavioural intention post education predicts subsequent reporting behaviour. Findings suggest that more must be done if the health of student-athletes is to be	Modest sample size Assessed effectiveness of education in context and not necessarily the education material themselves. While the very high individual response rate eliminates the possibility of response bias within teams, not all league teams participated, with team coaches making the final decision about team eligibility.

Reference	BSSTM used	Trifiletti BSSTM Application	Population	Target Behaviour	Study Design	Findings	Study Recommendations	Limitations
							adequately protected. Among the present sample of Division 1 hockey players, a general directive to provide concussion education to players does not appear to be effective. At a minimum, we recommend that the NCAA 's directive be expanded to recommend concussion education materials that have demonstrated effectiveness in increasing concussion reporting intention and behaviour. Beyond the NCAA, as states and other sports leagues mandate concussion education for players, it is important that theory-driven education programmes are developed and evaluated, and that policy recommendations with respect to education programmes are evidence based.	Despite the similarity of participating and non participating teams in terms of win percentages over the previous season, it is very possible that coach attitudes about concussions and concussion education are systematically related to team participation. the generalisability of these findings to other sports, ages, genders and levels of competition may be limited. while observational and experimental evidence relatively consistently finds that behavioural intention predicts behaviour this as yet to be tested for concussion reporting
Finch et al., (2014) #	HBM	1	1564 players participated in the PAFIX RCT. Of these, 442 players (28.3% enrolled PAFIX players) completed surveys at postseason. 192 players-NMC; 250 control program.	SET	Nested within a larger group clustered randomised controlled trial of the effectiveness of two exercise-training programmes (control and neuromuscular control (NMC)) for preventing knee injuries.	Compared with control players, those who participated in the NMC programme found it to be less physically challenging but more enjoyable and potentially of more benefit. Suggestions from players about potential improvements to the training programme and its future implementation included reducing duration, increasing range of drills/exercises and promoting its injury prevention and other benefits to players.	Players provide valuable feedback about the content and focus of implemented exercise-training programmes, that will directly inform the delivery of similar, or more successful, programmes in the future. As the programmes are delivered by coaching staff, establishing the views of coaches, and how they relate to those of their players, will also be important.	It was nested within a larger RCT and so the number of players available to complete the end-of-season survey was limited by the number who attended training sessions at the end of the season no information about why players did or did not attend training sessions towards the end of the season, but one possible reason for non-attendance could be related to the likelihood of the players'

Reference	BSSTM used	Trifiletti BSSTM Application	Population	Target Behaviour	Study Design	Findings	Study Recommendations	Limitations
					post-season self-report survey, to obtain players' views about the benefits and physical challenges of the programme in which they participated.			teams progressing to the final series The overall response rate, in proportion to all enrolled trial players, was 28% but as this was consistent across study arms there was unlikely to be a differential response according to the nature of the specific training programme delivered. However, we have previously described attendance of the players in the training sessions throughout the season and shown that at most only 40% of them attended training in the final 4 weeks of the season, when this survey was conducted. do not have information about the nonresponders' views of the training programmes and it is possible that they could be different to what is reported here. All information collected in the surveys reflect the subjective views of the players and their self-assessments of the training programmes. As such, their rating of programme intensity, etc will be subjective and it was not possible to confirm this with direct observation. Suggestions about how to improve the programmes and their delivery were only given by a subset of players.

Reference	BSSTM used	Trifiletti BSSTM Application	Population	Target Behaviour	Study Design	Findings	Study Recommendations	Limitations
								Nonetheless, suggestions they gave about what would motivate them to continue with the programme will be valuable for informing future prevention programmes.
Register-Mihalik et al., (2013) #	TRA/TPB	2,3	167 High school athletes, average age 15.4	Concussion Reporting Athletes intentions to report sport-related concussion	Cross-sectional survey	Direct attitude, subjective norm and direct perceived behavioural control were all associated with intention to report concussion. Intention was associated with increased prevalence of participation in practices and games while symptomatic from concussion.	Favourable attitudes toward reporting and social referent' beliefs have the greatest impact on intention to report concussion symptoms. Reporting intention may not always be an indicator of concussion-reporting behaviours. Concussion education initiatives should focus on improving attitudes and beliefs among athletes, coaches and parents to promote better care-seeking behaviours among young people. Clinicians are an important part of sports culture and may use this study's findings to help develop and implement multilevel educational interventions designed to increase reporting of concussion symptoms among high school student-athletes. Highlights the role that several TRA/TPB constructs may play when reporting concussion-related symptoms in games and practices among high school athletes.	Although the purpose of the study was not to make population estimates; however it should still be noted that this was a convenience sample of schools and students. The relatively low student-athlete response rate (10%) introduced response bias to the study. A large percentage of participants (41.5%) in this study were football players, which may also have influenced study findings. Time of reporting in proximity to the event was not obtained, which made it difficult to know whether an athlete's reporting of a concussive event was linked to the time of injury. The sample size for gender comparisons was also small. Future work should expand on these comparisons. These results are based on self-report and may be subject to recall bias; however, this study was aimed at understanding athlete perceptions about concussive-related events.

Reference	BSSTM used	Trifiletti BSSTM Application	Population	Target Behaviour	Study Design	Findings	Study Recommendations	Limitations
							This study provides a framework for using health behaviour theory in future studies to better understand injury-related behaviours.	During the study period, a significant amount of attention was focused on concussion in sport, which may have influenced the data collection by increasing knowledge and awareness.
Rigby et al, (2013) #	TPB	1,2,3	221 certified ATs working in secondary school/clinic, high school, and college/university settings.	Concussion guidelines – Concussion Management Practice.	A Web link with a survey was e-mailed to 1000 randomly selected members of the National Athletic Trainers' Association (NATA).	found that BA, SN, and PBC predicted BI ($R = 0.683$, $R(2) = 0.466$, $F_{3,202} = 58.78$, $P < .001$). The BA ($t_{202} = 5.53$, $P < .001$) and PBC ($t_{202} = 9.64$, $P < .001$) contributed to the model, whereas SN ($t_{202} = -0.84$, $P = .402$) did not. The PBC and BI predicted behavior ($R = 0.661$, $R(2) = 0.437$, $F_{2,203} = 78.902$, $P < .001$).	In this sample, the TPB constructs predicted BI and behavior of ATs' compliance with recommended concussion-management guidelines. The BA and PBC were the most influential constructs, indicating that those with positive attitudes toward concussion-management recommendations are more likely to implement them, and ATs are less likely to implement them when they do not believe they have the power to do so. We theorize that interventions targeting ATs' attitudes and control perceptions will lead to improved compliance.	inherent limitations of survey research are associated with the study. a lower-than-desired response rate of 22.1%, which may reflect the time of year we distributed the instrument. Collected sample in the late fall, when many ATs are transitioning from fall to winter sports. Of those who responded, only 3.4% worked in the college/ university setting, whereas 92.2% of the respondents worked in the secondary school/clinic or high school setting. Because we sought to study ATs who work closely with contact sport athletes, results are not comprehensive to all ATs. Those who work in other settings in which concussions occur, such as professional sports and the military, may have different beliefs and practice patterns toward the current recommended guidelines. ATs' general lack of familiarity with TPB questions.

Reference	BSSTM used	Trifiletti BSSTM Application	Population	Target Behaviour	Study Design	Findings	Study Recommendations	Limitations
Kroshus et al, (2014) #	TPB	2,3	256 American Tier III junior A ice hockey league players	Concussion Reporting	Cross-sectional surveys	Results supported the fit of the TPB-based model in explaining reporting behaviour; all model pathways were significant in the hypothesised direction. Of the perceived reporting outcomes assessed, those related to athletic performance were identified as most strongly identified with reporting intention.	Important to consider factors such as perceived outcomes of reporting, perceived norms, and self-efficacy, in addition to knowledge, when analysing concussion underreporting among adolescent athletes. As concussion education becomes increasingly mandated, testing and applying psychosocial theories such as the TPB may help increase program efficacy. Population and context-specific perceived consequences should be communicated to athletes.	-
Kroshus et al., (2014) #	TPB	1,2,3	256 late adolescent males from 12 teams in a single league of ice hockey competition in the United States	Concussion Education	Pilot randomized controlled study, theory-driven evaluation of three publically available concussion education materials: two videos and one informational handout. Surveys assessing postimpact symptom reporting behavior, concussion knowledge, and	Results indicated no change in any measure over any time interval, with the exception of perceived underreporting norms. In one of the video conditions, perceived underreporting norms increased significantly 1 day after viewing the video. Possible content and viewing environment related reasons for this increase are discussed. Across all conditions, perceived underreporting norms increased 1 month after intervention receipt, raising the possibility that late in the competitive season underreporting may be perceived as normative.	The need for the development of theory-driven concussion education materials, drawing on best practices from health behaviour scholars, is discussed.	Possible that the lack of change observed for some of the cognitive variables is attributable to the insufficiency of the measures rather than a lack of change in the underlying constructs of interest. It is possible that the apparent lack of effectiveness of these educational materials was because the 1-month follow-up period was not long enough for adequate variability in reporting behaviour and that significant differences based on condition may have been seen with longer follow-up. It is also possible that the apparent lack of effectiveness of these materials was a

Reference	BSSTM used	Trifiletti BSSTM Application	Population	Target Behaviour	Study Design	Findings	Study Recommendations	Limitations
					concussion reporting cognitions were completed by participants immediately before receiving their educational intervention, 1 day after, and 1 month after.			function of the population studied. Athletes in this sample had been playing organized hockey for an average of approximately 13 years. It is likely that within that timeframe they had been exposed to a substantial amount of information about concussions. Consequently, the information provided by the educational materials in this study may not have been new to them or may not have been sufficient to dislodge long-held beliefs, such as the perceived threat of concussions or what they perceive to be positive or negative consequences of reporting symptoms of a concussion.

HBM= Health Belief Model; TRA= Theory of Reasoned Action; TPB= Theory of Planned Behaviour; ASE model= Attitude-Social influence-self Efficacy Model; SCT= Social Cognitive Theory; DIT= Diffusion of Innovation Theory; PP (PRECEDE-PROCEED)=Predisposing, Reinforcing, and Enabling Constructs in Educational/Environmental Diagnosis and Evaluation-Policy, Regulatory, and Organisational Constructs in Educational and Environmental Development; OC= Ottawa Charter; EcoM= Ecological Model; PSus= Perceived Susceptibility; PSev= Perceived Severity; IM=Intervention Mapping; SDT=Self-D etermination Theory; AF=Australian Football; RL=Rugby League. Note: studies marked (#) have been published since the McGlashan and Finch Published review, these were not included in the main body of chapter 3, but are acknowledge here as studies conducted using BSSTM to outline the progress in the area. Note: *BSSTM application based on Trifiletti and Michie coding- 1. Guide program design and/or implementation, evaluation; 2. Measure theory or construct; 3. Tested theory; 4. Other (McGlashan & Finch, 2010).

Appendix F: Coach Literature Analysis Data

Coach Review: Summary List Included Studies (n=27 studies)

1. Bell, P. A. (1992). Spondylolysis in fast bowlers: Principles of prevention and a survey of awareness among cricket coaches. *British Journal of Sports Medicine, 26*, 273-275.

2. Berg, R., Berkley, D. B., Tang, J. M. W., Altman, D. S., & Londeree, K. A. (1998). Knowledge and attitudes of Arizona high school coaches regarding oral-facial injuries and mouthguard use among athletes. *Journal of American Dental Association,129*, 1425-1432.

3. Carter, A. F., & Muller, R. (2008). A survey of injury knowledge and technical needs of junior rugby union coaches in Townsville (North Queensland). *Journal of Science and Medicine in Sport*, *11*, 167-173.

4. Danis, R. P., Hu, K., & Bell, M. (2000). Acceptability of baseball face guards and reduction of oculofacial injury in receptive youth league players. *Injury Prevention, 6*, 232-234.

5. Duymus, Z. Y., & Gungor, H. (2009). Use of mouthguard rates among university athletes during sport activities in Erzurum, Turkey. *Dental Traumatologya, 25,* 318-322.

6. Gianotti, S., Hume, P. A., & Tunstall, H. (2008). Efficacy of injury prevention related coach education within netball and soccer. *Journal of Science and Medicine in Sport*, doi:10.1016/j.jsams.2008.07.010

7. Gilchrist, J., Mandelbaum, B. R., Melancon, H., Ryan, G. W., Silvers, H. J., Griffin, L. Y., . . . Dvorak, J. (2008). A randomised trial to prevent noncontact anterior cruciate ligament injury in female collegiate soccer players. *American Journal of Sports Medicine, 36,* 1476-1483.

8. Glang, A., Koester, M. C., Beaver, S., Clay, J., & McLaughlin, K. (2010). Online training in sports concussion for youth sports coaches. *International Journal of Sports Science and Coaching*, *5*(1), 1-11.

9. Iversen, M. D., & & Friden, C. (2008). Pilot study of female high school basketball players' anterior cruciate ligament injury knowledge, attitudes, and practices. *Scandinavian Journal of Medicine and Science in Sports,* , 1-8.

10. Joy, E. A., Taylor, J. R., Novak, M. A., Chen, M., Fink, B. P., & Porucznik, C. A. (2013). Factors influencing the implementation of anterior cruciate ligament injury prevention strategies by girls soccer coaches. *Journal of Strength and Conditioning Research, 27*(8), 2263-2269.

11. Lang, B., Pohl, Y., & Fillippi, A. (2002). Knowledge and prevention of dental trauma in team handball in Switzerland and Germany. *Dental Traumatology, 18*, 329-334.

12. Lawrence, D. W., Stewart, G. W., Christy, D. M., Gibbs, L. I., & Ouellette, M. (1997). High school football-related cervical spinal cord injuries in Louisiana: The athlete's perspective. *Journal of Louisiana State Medical Society, 149*, 27-31.

13. Lehl, G. (2005). Perception of chandigarh sports coaches regarding oro-facial injuries and their prevention. *Journal of Indian Society of Pedodontics and Preventive Dentistry, 23*(2), 67-70.

14. McGuine, T. A., Hetzel, S., Pennuto, A., & Brooks, A. (2013). Basketball coaches' utilization of ankle injury prevention strategies. *Sport Health: A Multidisciplinary Approach, 5*, 410-416.

15. Montelpare, W., McPherson, M., Sutherland, M., Faught, B. E., Baker, J., Keightley, M., Taha, T. (2010). Introduction to the play it cool safe hockey program. *International Journal of Sports Science and Coaching, 5*(1), 61-74.

16. Mzarik, M., Bawani, F., Krol, A.L. (2011). Sport-related concussions: knowledge translation among minor hockey coaches. Clinical Journal of Sports Medicine, 21 (4), 315-319

17. Onyeaso, C. O., & Adegbesan, O. A. (2003). Knowledge and attitudes of coaches of secondary school athletes in Ibadan, Nigeria regarding oro-facial injuries and mouthguard use by the athletes. *Dental Traumatology, 19*(4), 204-208.

18. Persic, R., Pohl, Y., & Fillippi, A. (2006). Dental squash injuries - a survey among players and coaches in Switzerland, Germany and France. *Dental Traumatology, 22*, 231-236.

19. Pettersen, J. A. (2002). Does rugby headgear prevent concussion? attitudes of Canadian players and coaches. *British Journal of Sports Medicine, 36*, 19-22.

20. Ranalli, D. N., & Lancaster, D. M. (1995). Attitudes of college football coaches regarding NCAA mouthguard regulations and player compliance. *Journal of Public Health Dentistry, 55*(3), 139-142.

21. Saunders, N., Otago, L., Romiti, M., Donaldson, A., & Finch, C. (2010). Coaches' perspective on implementing an evidence-informed injury prevention programme in junior community netball. *British Journal of Sports Medicine, 44*(15), 1128-1132.

22. Sawyer, R. J., Hamdallah, M., White, D., Pruzan, M., Mitchko, J., & Huitric, M. (2008). High school coaches' assessments, intentions to use, and use of a concussion prevention toolkit: Centres for disease control and prevention's heads up: Concussion in high school sports. *Health Promotion Practice Online First, 10.1177/1524839907309377*doi:10.1177/1524839907309377

23. Shehab, R., Mirabelli, M., Gorenflo, D., & Fetters, M. (2006). Pre-exercise stretching and sports related injuries: Knowledge, attitudes and practices. *Clinical Journal of Sports Medicine, 16*(3), 228-231.

24. Soligard, T., Nistad, A., Steffen, K., Mykelbust, G., Holme, I., Dvorak, J., Andersen, T. E. (2010). Compliance with a comprehensive warm-up programme to prevent injuries in youth football. *British Journal of Sports Medicine, 44*(787), 793.

25. Twomey, D., Finch, C. F., Roediger, E., & Lloyd, D. G. (2009). Preventing lower limb injuries: Is the latest evidence being translated into the football field? *Journal of Science and Medicine in Sport, 12*(4), 452-456. doi:10.1016/j.jsams.2008.04.002

26. White, P. W., Otago, L., Saunders, N., Romiti, M., Donaldson, A., Ullah, S., & Finch, C. F. (2014). Ensuring implementation success: How should coach injury prevention education be improved if we want coaches to deliver safety messages during training sessions? *British Journal of Sports Medicine, 48*, 402-403. doi:doi:10.1136/bjsports-2012-091987

27. Yang, J., Bowling, M., Lewis, M. A., Marshall, S. W., Runyan, C. W., & Mueller, F. O. (2005). Use of discretionary protective equipment in high school athletes: Prevalence and determinants. *American Journal of Public Health*, *95*(11), 1996-2002.

Descriptions of theoretical and atheoretical studies

Description of theoretical-based studies

The use of Individual-level (intrapersonal and interpersonal) Behaviour Change Models

The individual level is relevant to theories at the intrapersonal and interpersonal level. The intrapersonal level, refers to an individual's (e.g. the coach) knowledge, attitude and beliefs on his or her behaviour (Gielen, 2006). Theories of cognition, perception, and motivation are relevant at the intrapersonal level. The interpersonal level, refers to how significant other people, such as family members, friends, players/athletes, presidents influence an individual's (e.g. coaches) behaviour (Gielen, 2006), Theories particular relevant to interpersonal relationships include those related to social influences.

In this summary, three studies are presented that have utilised individual level theory to either understand coaches' perceptions about injury risk and prevention and the efficacy of preventive measures. Briefly, the health belief model suggests that the likelihood of taking action is based on the belief about susceptibility and severity of injury and the benefits of taking specific action (Janz, 1984). The theory of reasoned action and the related theory of the planned behaviour focus on the intent and influence of perceptions about subjective norms and attitudes towards behaviour (Ajzen, 1991, 2010). Finally, social cognitive theory focuses on skill, outcome and efficacy expectations as being central determinants to behaviour, it also states that behaviour, the person, and the environment interact dynamically (Bandura, 2000).

Social Cognitive Theory

Yang et al., (2005) described the use of lower extremity discretionary protective equipment (LEDPE) among high school athletes and examined how social and behavioural determinants consistent with Social Cognitive Theory influenced equipment use. Specific to the coach, the authors explored both social environment (player/coach ratio) and behavioural capability (coach experience, qualifications

and training) factors. Findings from this study, however, indicated no association between coach experience, qualifications and training with the coaches' athletes' increased use of LEDPE, although a low player/coach ratio was associated with enhanced use of LEDPE.
Theory of Reasoned Action/Theory of Planned Behaviour
Iversen et al., (2009) used the Theory of Reasoned Action and the Theory of Planned Behaviour as a framework to: (1) characterise female high school basketball players and coaches knowledge, attitudes, and beliefs about anterior cruciate ligament (ACL) injury risks and injury prevention practices; (2) to examine the effectiveness of an educational program on players coaches knowledge about the le of the ACL and ACL injury risk, attitudes towards ACL injury prevention and use of injury prevention practices. The authors hypothesised that improved knowledge in coaches about the function of the ACL and ACL injury risk an instruction in injury prevention practices would influence attitudes towards injury risk and, in turn, impact the practices of coaches and players. Both players and coaches completed a baseline questionnaire prior to participating in a 45-minute educational and skills-based intervention on the anatomy and function of the knee and the ACL, risk factors for ACL injuries, and risk reduction techniques. The baseline survey assessed knowledge (anatomy, function, and ACL injury risk factors), attitudes/beliefs (towards ACL injury risks and prevention), and players and coaches practices associated with ACL prevention techniques. The findings indicated that program was well received by both coaches and players. Knowledge about the ACL and injury risk factors for ACL increased significantly post-implementation, however there were no significant changes in attitudes toward injury risk or self-report injury practices. Observed use of two footed landings, a desired behaviour on the part of the players that the coach was responsible for, improved during the study. However, there was no strong correlation of self-report use of preventive practices and observed use. Changes in knowledge, attitudes and practice varied by school. Coaches who scored higher on the ACL knowledge scale, reported more favourable attitudes towards ACL injury prevention techniques and practices. Players, linked to these coaches also scored higher, on average, post-program

implementation. In contrast, one school whose coach scored lowest on knowledge, attitudes and behavioural components, demonstrated negative changes post-program among players.
White et al, (2014) used the TPB 51 Junior community netball coaches from 2 netball associations in Victoria, Australia complete cross-sectional surveys Overall >94% of coaches had strong positive attitudes towards toward teaching correct landing technique and >80% had strong positive perceptions of their own control over delivery of such programs. Coaches' ratings of social norms relating what others think about teaching safe landing technique were more positive (>94%) than those relating to what others do (63-74%). Junior coaches are generally receptive toward delivery safe landing training programs in the training sessions they led. Future coach education and opportunities for communication for communication between coaches about what they are/are not doing could include role modelling by prominent coaches so that more community-level coaches are aware that this is a behaviour that many coaches can, and do, engage in. Although sporting bodies can place expectations on coaches to deliver safety programs in their training sessions, coaches' actual actions may depend on how competent they believe they are to do so. Coach education that provides the skills/strategies necessary to implement these programs, including how to generate and maintain player motivation, could assist with this.
Health Belief Model, Expanded Theory of Reasoned Action, and Social Cognitive Theory
Glang et al., (2010) used a combination of theories in the development and evaluation of an online training program (*ACTive*: Athletic Concussion Training using Interactive Video Education) related to sports concussion for youth sports coaches. The authors used the Health Belief Model as a conceptual framework underlying the development of the training, and used the Expanded Theory of Reasoned Action to deliver key messages by referent others in the training. The evaluation component was reported to be based on the Social Cognitive Theory, the Health Belief Model, and the Theory of Reasoned Action. The purpose of the evaluation was to document whether the ACTive program,

when compared to a control group, had effects on coaches' knowledge, attitudes, intention and self – efficacy. Unfortunately not all items of these theories were assessed, nor were they specifically linked to any one theory overtly by the authors. Usability, acceptability and user satisfaction related to the online coach education were also assessed. These particular components appear consistent with measures of the perceived benefits/barriers constructs in the HBM, however this was not directly reported. The results of the trial indicated that coaches who viewed the ACTive program showed significantly greater improvement than those who viewed the CDC safety materials in: (a) their knowledge of concussion symptoms and general knowledge of concussion; (b) their self-efficacy regarding recommended actions following concussions like those presented in the sample scenarios; (c) their intention to take appropriate action in situations like those presented in the scenarios, and (d) their attitudes about brain injury. Overall, the authors reported that the improvements in the knowledge, self-efficacy, intentions, and attitudes of coaches suggest that the training had measurable effects on coaches' understanding of how to prevent and manage sport concussion. The authors noted that they could not predict whether coaches would use the skills in practice or game situations or whether changes in knowledge, self-efficacy, intentions and attitudes would be maintain over time.
Summary of individual-based theories Individual based theories have recently emerged in coach injury research in an effort to better understand factors associated with coach injury-related behaviours. Theory has also been used to develop interventions that were evaluated in randomised controlled trials, providing information about the theory and also evidence of program efficacy. Unfortunately, given the range of injury types, injury prevention behaviours and the uniqueness of various target populations it is difficult to draw conclusions about the utility of individual-based theories across the numerous coach injury prevention studies. While evidence from a single study can provide useful information about what factors to target or about program efficacy, only multiple studies and replication studies carried out on many different injury prevention behaviours and among different populations can lead to evidence for best practices. What is needed is substantial research on both the determinants of behaviour and the efficacy of

behaviour change interventions using behavioural science theory, methods, and applications. This information would fuel recommendations to coach researchers, sport practitioners and coaches about the most important factors to address and the program components that are most likely to succeed, Most noticeably absent from this body of literature on individual based theories is longitudinal study designs and mediator models of analysis, both of which would aid in understanding behaviour over time and influencing factors that account for any change. Nevertheless, this review should enable coach researchers and practitioners in injury prevention to more easily identify potentially useful theoretical approaches to a sport injury problem of interest relevant to the coach.
Community Models and Approaches in Coach-related Interventions The community level considers organisational settings and their influence and social and injury/health policies (Gielen, 2010). Coggan and Bennet (2004) state that community-based injury prevention "occurs when people and organisations collaborate as communities to design and implement strategies to promote safety, reduce the incidence and/or severity of injury in their population, and reduce the prevalence of injury determinants in the community" (p. 349). An understanding of the functioning of individuals, groups (e.g. sporting teams), organisations (NSOs), large social institutions, and communities is vital in assisting preventive enhancements among coaches. Asking questions such as; (1) how do social systems operate within sport?; (2) how do changes occur within and among sporting systems?; and (3) how do community and organisational changes in sport influence people's behaviour and health?, are important (Gielen, 2006). Community models to assist in the understanding of the levels of influence on coaches' preventive behaviour include - Models of Community Organisation and Community Building, Organisational Development Theory, Diffusion of Innovations and Communications Theory. To date two studies applying the Diffusion of Innovations and the RE-AIM have been conducted.
Diffusion of Innovation
Sawyer and colleagues (2008) conducted a large pilot study to evaluate coaches' perceptions, assessments and use of a toolkit (Heads Up: Concussion in High School Sports) designed to assist

them prevent and manage concussion among high school athletes. The toolkit was developed by the Centres for Disease and Control in the United States and incorporated the use of the Diffusion of Innovation in dissemination and evaluation of the program. The study findings indicated that most coaches used, or had planned to use, the toolkit materials. Over 80% of coaches indicated that their school had an existing concussion plan for preventing and managing concussion, however stated that the "Heads Up" toolkit could be used to improve this. Mostly all coaches from schools who did not have a written concussion plan reported that the toolkit could be utilised as a basis to develop one. Coaches reported the advantages of the toolkit were that it was visually appealing, easy to use and contained appropriate content. The coaches who already had existing plans for concussion prevention and management indicated greater satisfaction with the toolkit. There were no significant differences among coaches with differing professional experience or for sports with different injury rates.
RE-AIM framework
Saunders et al., (2010) explored coaches' perceptions of, and suggestions for improvement, in relation to implementing a safe-landing techniques programme, Down to Earth (D2E). This program was a netball-specific landing programme focused on reducing lower limb injuries for junior players. Thirty-one coaches undertook a 1-hour workshop on the D2E and then conducted a 6-week program within their training session. A follow-up survey was provided to coaches 17 weeks after completion of the D2E program. The RE-AIM framework was applied to assist in evaluating the D2E programme among coaches. Most coaches believe that the D2E program improved their players' ability to perform correct landing technique in games and that players' had retained these improvements over the season. The majority indicated the major benefits were improvements in athletic attributes, followed by reduction of injury and learning correct technique. The barriers of the D2E were perceived among coaches to be time factors (often running out of time to do all drills) and some younger players having difficulties with undertaking the drills. Other barriers included challenges of working with young children, including poor concentration and motivation and the perceived value of

injury prevention by young players. The majority of the coaches indicated that they would continue to use the D2E in their training programs. Coaches also reported that they needed more ideas of drills that could be incorporates into this training sessions and their own coaching training did not prepare them to implement injury prevention programs.

Summary of Community Models and Approaches

To date, there has been limited use of community based models and approaches associated with the coach in the sport context. The principles of community intervention are particularly relevant to sport injury prevention and the interplay of the coaches' role within the sport environment; they can help shape effective programs, regardless of whether the desired outcomes are individual behaviours or environmental modifications or both. By engaging intended audiences as partners and using the tenets and theories such as the DIT and other not mentioned in this review (e.g. community mobilisation), sport injury researchers and professionals can more powerfully communicate both personal protection messages and the demand for safer environments. It is also noted that it is important to utilise individual-based theories with community-based theories and models (Gielen, 2006).

Description of atheoretical studies (studies summarised by type of prevention measure and mapping of factors)

Personal Protective Equipment

Mouthguards

Ranalli (1995) conducted a study to assess the attitudes of Division 1-A college head football coaches regarding the NCAA mouthguard regulations, current patterns of use by players, and responsibility for enforcement. They also compared the coaches' responses with those from on-field officials obtained in a previous study (Ranalli & Lancaster, 1993; Lancaster & Ranalli, 1993). A 15-item questionnaire was mailed to 106 Division 1-A football coaches to assess their attitudes. Responses were received from 98 coaches. Overall, coaches viewed themselves, the players, or the trainer as being most

responsible for players wearing mouthguards, not referees. The majority of coaches reported the team trainer was responsible for selecting the type of mouthguard used, despite most of them also reporting having a team dentist (87%). Over 50% of coaches reported that all players wore mouthguards, but the quarterbacks were least likely to wear them. Coaches reported that mouthguard rules and enforcement of rules was beneficial in determining player compliance and resulted in more frequent use. Seventy-four percent of coaches reported they would warn the player of a violation themselves and thus reinforcing mouthguard behaviour use, yet only 26% felt the coach had the greatest influence on players wearing mouthguards.
Berg (1998) assessed high school athletics coaches' perceptions about oral-facial injuries and mouthguard use in sports that did not mandate mouthguard use. An 11-item questionnaire was developed and mailed to 1043 coaches (response rate 43.7%) of nine sports (wrestling, boys and girls basketball, baseball, softball, soccer, and volleyball) listed in the Arizona Interscholastic Athletic Association directory. About 72% of the coaches reported that at least one oral-facial injury was sustained among their athletes in a season. The most common injuries reported by over 80% of coaches were a cut lip, tongue or cheek. Other injuries included a bruised face, loose or broken teeth and broken bones. Across all sports, 28% of coaches indicated that some athletes used mouthguards regularly, whilst nearly half of coaches perceived that athletes who had sustained an injury did not use mouthguards regularly. Only a small proportion (13.2%) of coaches reported providing any information on mouthguard use and oral-facial injury prevention to their athletes. Coaches' perception of injury occurrence among their athletes was also not found to be linked to coaches providing such education. Thirty-one percent of coaches reported they would not encourage mouthguard use, however about 60% of coaches stated they would encourage mouthguard use if free. Factors such as coaches' perception of injury occurrence and sport type were found to influence mouthguard use or not.
Onyeaso (2003) assessed the perceptions of secondary school sports' coaches about oro-facial injuries and mouthguards usage in sports by adolescent athletes. A 10-item questionnaire was

distributed to 42 coaches from 23 secondary schools in Ibadan city, Nigeria, in 2002. The questionnaire sought information on why a mouthguard was used, when it was required; the types of mouthguards used; the major reasons for selecting a particular mouthguard and perceived efficacy of whether a mouthguard could prevent oral injury. Most coaches (95.2%) believed that mouthguards prevent oral injuries and they would like further information on them. The main factors influencing the choice of mouthguard by coaches for their athletes was the quality of the oral protection, followed by the cost. Over 80% of coaches believed that mouthguards should be worn at all times by athletes, during practice and competitions, while 19% believed that use was only necessary during competitions. The type of sport influenced coaches beliefs about whether mouthguards should be worn, with the majority of coaches (71%) believed they should be worn in boxing, 2.4% believed they should be used in football (soccer) players and judo, while about 12% did not indicate any sport. Most of the coaches believed that a mouthguard was effective in protecting against oral-facial injuries, however believed that that had yet to be adequately informed so as to correctly advise and influence adolescent athletes.
Persic, Pohl, and Filippi (2006) conducted a comparative study between Switzerland, Germany and France. A face to face questionnaire was administered to 53 coaches from various leagues (junior to professional) about their observed and experience of injuries, tooth replantation and tooth rescue kit and mouthguards. About 68.5% of all coaches observed an orofacial injury, sign difference were found between countries and leagues; in France and Germany more injuries were observed than in Switzerland. It was difficult to determine the coach factors and how they differed from athletes as most of the results were discussed collectively.
In 2006, Cetibas and Sonmez (2006) investigated coach and athlete attitudes towards mouthguard use among children and adolescents, aged 11-18 years in Ankara, Turkey. The results of the coaches' survey indicated that none of the 11-18 year old children and adolescents used mouthguards while participating in sports. Most coaches (77.2%) had observed an orofacial trauma in this age group and 95.5% believed that mouthguards prevented orofacial injuries. Over 70% of coaches reported that

they believed mouthguards should be used by children and adolescents in sporting activities.

Similarly, another study conducted in Erzurum, Turkey by **Duymus and Gungor (2009)** surveyed 50 coaches and 768 university athletes (basketball, soccer and volleyball) to determine the extent of mouthguard use, the frequency of oral trauma and the attitudes of mouthguard users. The results of the coaches' survey indicated that none of the athletes used mouthguards while participating in sports. Of the coaches, 64% had witnessed an orofacial trauma in their athletes during sport activities, and 76% believed that mouthguard prevented oral injuries. Thirty-five percent of coaches reported they believed that university athletes should use mouthguards in sporting activities such as martial arts and boxing, however only 10% of coaches believed mouthguards were required in basketball, followed by 5% of coaches believing they were required in handball, soccer, skiing and other sports. No coaches reported influencing student's use of mouthguards, and most coaches (78%) indicated that they required more information about mouthguards.

Overall, the studies by **Duymus and Gungor (2009)**, and **Cetibas and Sonmez (2006)** indicated the use of mouthguards in Turkey is rare in sports, and coaches among other key professionals need to encourage the use of mouthguards in training and competition.

Headgear

Pettersen (2002) conducted a study to determine the attitudes of Canadian rugby players and coaches to the use of protective headgear, particularly with respect to the prevention of concussion. Although surveyed players believed that headgear could prevent concussion, the coaches were less convinced. Five of the nine coaches did not think the use of protective headgear reduced the incidence or severity of concussions; one coach was undecided and three believed that headgear was effective. Some coaches who did not believe headgear was effective in preventing concussion suggested its use could potentially lead to more concussion as the player may: "have a false sense of security", "learn to lead with their heads"; or even take a "kamikaze approach". They were concerned that padding in rugby

may evolve to that currently used in American football. Apart from potentially leading to more injuries, the coaches were worried that the cost of playing rugby would also increase.
Faceguards
Danis (2000) assessed the relative injury reduction effect and acceptability of face guards on baseball batters helmets. During the 1997 season, coaches, parents, and players among 238 youth league baseball teams in Central and Southern Indiana were asked to complete a pre and post-season questionnaire. Approximately one-half of the teams were supplied with faceguard helmets (intervention), other teams used at their discretion (comparison). Overall, parents, players and coaches on intervention teams reported a reduction in the incidence of oculofacial injuries compared with comparison team respondents. There was no reported adverse effect of face guard use on player performance. In prior seasons, about 50% of coaches reported that they had coached a child who was hit in the face but there was no significant difference between intervention and comparison team coaches. However, intervention coaches more often agreed that facial impacts were significant sources of injury and that faceguard use should be mandated. Coaches at post-season follow-up reported a 28% lower incidence of facial impacts/injuries among their players than comparison team coaches. There were also significantly more reports by intervention coaches of a potential injury after faceguard impacts compared to comparison teams. The proportion of team coaches (intervention) who agreed that faceguards should be mandated increased by 30%. In spite of faceguards availability and apparent acceptability, overall faceguards are rarely employed.
General PPE
Lehl (2005) collected questionnaire data from 40 coaches involved in training of athletes in high school, college and university levels in India. The study explored coaches' perceptions about oro-facial injuries and their causation, oro-facial protective equipment and their utilisation, and influence of player injuries on attitudes of coaches. Coaches' considered helmets as the most common

protective equipment, followed by mouthguards and faceguards. About 58% of coaches reported observing that boxing was mostly associated with oro-facial injuries and protective equipment was deemed mandatory by 68% of coaches in this sport. Nearly half of all coaches surveyed reported observing over five injuries over the last 12 months (47% of injuries being soft tissue and 33% resulting in tooth loss). Coaches reported most injuries occurred in hockey and 32% were due to contact injuries, such as getting hit by a ball, stick or related hard object. Over 80% of injuries were related to non-use of protective equipment. Such knowledge and observation of injuries by coaches motivated the majority of coaches to reinforce the use of oro-facial equipment and coaches indicated it should be used more among athletes/players, whilst 28% perceived that protective equipment reduced efficiency. Coaches also reported providing support and addressing parental concerns regarding sport injuries, with most coaches reporting that parental concerns were justified.
General Injury Prevention
Carter and Muller (2008) conducted a study to determine junior rugby union coaches' knowledge of the risk and protective factors of injury among junior players. 35 coaches completed a self-administered questionnaire. Most coaches were male, with an average age of 33 years. The highest completed education among 77% of coaches was university level. Most coaches had up to five years' experience coaching; over 60% had played rugby union and accredited Australian rugby union qualified coaches. In general, the findings suggested that coaches in this study had limited injury risk knowledge. While 71% of coaches identified the tackle as the game situation in which most injuries occur, only about half of coaches identified the upper limb of the tackler as the body part most likely to be injured in a tackle and one-quarter identified the lower limb of the ball carrier. Most coaches (97%) believed that previous injury increased the risk of re-injury. Coaches who had more experience in coaching (higher number of seasons coached) also had greater injury risk knowledge. Having an Australian rugby union qualification was also associated with improved sport-specific technical skills. However, no correlation between other demographic factors (e.g. age, highest level of education),

risk, and protective factors were not reported. The authors noted that this study demonstrated that coaches of junior rugby teams require education of the mechanisms of injury and procedures for early management of minor and soft tissue in rugby union courses. In addition, the authors also commented that further research is required to investigate the perceptions of coaches towards player susceptibility for tackle injuries. Coaches with no experience or qualifications should be targets for structured introductory courses detailing the necessary skills and techniques for safe play prior to commencing coaching.
Specialised Exercise Programs
Bell (1992) conducted interviews with three cricket coaches to establish their perceptions of back injury (spondylosis), with an emphasis on preparation of fast bowlers and the roles of technique alteration and bowling prescription in reducing back injury. Two of the coaches were head-coaches of first class county sides. One had played as an all rounder for England, and the other in county second cricket. The third coach was an ex-county fast bowler and involved in school, club and county young cricketer's coaching. All were aged between 55 and 60 years. The coaches appeared to have a degree of awareness of back injury in general, and spondylolysis in particular. Only one coach believed that back injury was common among young cricketers that he coached, and none of the coaches believed that back injury accounted for a significant drop-out rate. However, all agreed that back injury now appears more common in the professional game than it was historically, and that the modern-day fast bowler is more front-on, in position which was perceived to be linked to a higher chance of sustaining a back injury for fast bowlers. Coaches indicated that training programmes for fast bowlers were poorly defined and structured. There were no specific exercise regimes in flexibility, strength, speed and endurance and there was no individual exercise prescription or home exercises. The use of bowling technique prescription was also limited. One coach restricted net sessions to 45 minutes of bowling and another limited his young fast bowlers to five-over-spells. Technique alteration was used by all coaches, but not in an attempt to reduce injury risk. One actively encouraged a side-on

technique for its other benefits. One stressed the importance of observing and altering techniques when players are young. No formal video analysis was being conducted, although coaches thought they were monitoring players themselves through continual observation.
Shehab, Mirabellii, Gorenflo & Fetters (2006) assessed the knowledge, attitudes and practices of high school coaches regarding pre-exercise stretching (PES). Seventy-one head coaches at ten high schools throughout southeast Michigan in the United States completed a survey. Most coaches believed that PES was beneficial; nearly all coaches believe that PES prevented a wide array of injuries, improved conditioning, established a rhythm, and assisted improve mental preparation among athletes. Half of the coaches also believed that it also provided a socialisation aspect. On average, coaches facilitated stretching activities with their athletes 13 minutes prior to competition or training. Only some coaches believed that PES had drawbacks. Although coaches acknowledged that PES takes times away from other potential forms of preparation, the majority of coaches reported that this was not an important barrier in using PES in their coaching practices. In addition, most coaches believed that the possibility of injury or fatigue was not a barrier to PES. Most coaches believed that PES does not increase the risk of injury and over 75% believed PES decreases the frequency of muscle cramps and strains, and ligament sprains. Almost 50% of coaches believed that PES could decrease the rate of dislocations, 44% believed neck injuries are reduced and almost a third stated PES would reduce fractures. A few also reportedly believed that PES increases the risk of joint dislocations. Coaches reported that they were influenced by personal experiences and scientific research, in addition to other coaches' recommendations, national guidelines, and specific school association guidelines. Coaches that were older and more experienced believed that PES was less effective and female coaches perceived more strongly that PES establishes a rhythm for participation and influences athlete's socialisation. The authors commented that there was an obvious disconnect between recent evidence and current practice among high school coaches. Moreover, mounting evidence from research (e.g., Thacker, 2004; Small, 2008; McHugh, 2010) suggesting that there is contradictory evidence or little or no benefit of PES in preventing injuries in normal athletes.

However, there is no sufficient evidence to endorse or discontinue routine stretching before exercise to prevent injury. Providing evidence to coaches should be a priority and new modalities that could decrease sport injury be integrated into activity preparation.
Twomey (2008) investigated the knowledge, attitudes and behaviours of coaches towards lower limb injury prevention in Australian football. Coaches from nine clubs in the Sydney Australian Football League (SAFL) completed a semi-structured questionnaire. Information was collected on coaches': (1) ratings of the importance of different elements of training sessions with respect to team performance and lower limb injury prevention; (2) perceptions of how specific training programs could prevent lower limb injuries; and (3) general attitudes to, and knowledge about lower limb injury risk and prevention. Direct observation of the duration and focus of training sessions were also made at each club on a randomly selected week. Skills chosen for observation included: warm-up, drills/set plays, ball handling skills, kicking skills, sprinting, weight/resistance training, jumping/landing training, changing direction/side stepping, balance training, endurance training and cool-down. Coaches 'generally ranked training elements associated with the game of Australian football as most important to include in their training sessions (e.g., warm-up run, warm up stretches, drills and set plays, ball handling skills, kicking skills, endurance/fatigue training and cool-down/stretches). The most important elements for team performance were considered to be game-related skills of ball handling, kicking skills, as well as warm-up cool down. Most coaches strongly favoured warming up and cooling down as injury prevention measures, however change of direction/side stepping training was considered of little/no importance. Only one-third of coaches believed that balance training had some importance for injury prevention. Drills and set plays, ball handling skills and kicking were considered to be at least importance to injury prevention. The beliefs about training elements were consistent with the content of the observed coach-led training sessions, in that, the most time was spent on game-related skills training. Only one club had a structured warm up. In contrast to coaches' importance rating for endurance training for team performance, five teams did not include this in

observed training sessions. Sprinting was observed at seven clubs, despite coaches generally indicating that they were unconvinced of its important. Little or no time was spent on balance, jump/landing and sidestepping techniques. Most coaches agreed that it was important to be familiar with current LLI strategies and that prevention was an important part of training. All coaches agreed they would implement specific training if it both improve performance and prevented LLI, however there was some doubt among coaches if it was only one or the other.
Gilchrist et al (2008) conducted a randomised controlled trial to examine whether the use of an alternative warm-up to enhance neuromuscular and proprioceptive control can reduce the number of anterior cruciate ligament (non-contact) injuries in the National Collegiate Athletic Association (NCAA) Division 1 female soccer players. The alternative warm up program used in this study was called the Prevent Injury and Enhance Performance (PEP) program. The program included basic components in stretching, strengthening, plyometrics, agility, and avoidance of high-risk positions depicted on a video that was disseminated to each intervention team. Additionally, teams (coaches and players) were provided with replacement exercises to help alleviate boredom with the program. The video and supplemental written materials emphasised the importance of correct biomechanical technique in completing the exercises and vidual examples of proper and improper biomechanical technique for each individual exercise. The coaches and the certified athlete trainers (ATCs) were asked to monitor the program and highlight technique and provide direct feedback on technique to the athletes. The program was delivered over 12 weeks (intervention teams were asked complete warm-up 3 times per week; control teams performed their customary warm-up) which coincided with the regular season schedule which was 12 weeks. As part of this study, coaches of the 8 participating teams completed surveys about their knowledge, attitudes, beliefs and behaviours regarding injury prevention in women's soccer to assess any differences between intervention and control groups. Certified athletic trainers from all participating teams (both intervention and control), with input from coaches and strength trainers, were asked to complete an end of season survey regarding training drills performed on filed, in the gym, or during weight room workouts covering the use of common

proprioceptive and neuromuscular training drills, including those included in the PEP program. The findings indicated responses from the coaches' survey did not differ substantially between intervention and control teams (unfortunately information related to these factors was not reported). The ATC's of the control teams reported that the coaches did not routinely use plyometric training or agility drills on field, the weight room or during off-field practice time. The ATCs of the intervention teams similarly reported little additional plyometric or agility drills outside of the alternative warm-up used by teams. Although the authors noted the program can be readily incorporated into practice time of collegiate soccer players, reported compliance with the warm-up program varied with intervention teams, some teams only implemented it 12 times, whereas others implemented it up to 37 times, the average number of warm-up seasons implemented was about 26 sessions. However the reasons for implementing, or not, were not clear.
Joy et al., (2013) Quantitative Only 19.8% of coaches responding implemented a team ACL IPP. Of those implementing a program, 61% coaches' teams in urban areas, 36% coached teams in semi urban area, and 4% coached teams in rural area. Coaches with more than the median number of years coaching experience (7 years) were more likely to have a ACL IPP than less experienced coaches. There was no other association identified between having a prevention program and other coach characteristics. The number of personnel (e.g., assistant coach, athletic trainer for the team) was correlated with the likelihood of reporting an ACL IPP. Specific types of support personnel were also associated with having an ACL prevention program. Teams that included a strength and conditioning coach had the greatest odds of having a prevention program compared with teams lacking such an individual. Teams with more than 2 support personnel were also more likely to have a prevention program than teams with fewer staff. Qualitative Unanimous agreement among coaches identified as best practice coaches that there was performance

enhancement benefits of ACL IPPs (BENEFITS), education should be required for licensure, and dissemination and implementation will require policy enactment with soccer associations (CUES TO ACTION/ACTION PLANNING). Several challenges and hurdles (BARRIERS) to implementing an ACL IPP - lack of knowledge on how to implement an IPP along with how to give adequate feedback to athletes on injury prevention techniques. Time restrictions (43%) and getting athletes and parents to support the program (43%) were also barriers. Overcoming hurdles/challenges (COPING PLANNING/SELF REGULATORY EFFICACY), positive attitude and acceptance (OUTCOME EXPECTANCIES/ATTITUDE/ACCEPTANCE) of change regarding injury prevention were important in their ability to implement. 36% coaches pursued self-education (LEARNING SELF-EFFICACY) and 29% reported efforts to educate parents and athletes on ACL injury prevention. The personal playing experience of coaches also contributed to successful implementation for 14% of coaches. Influences promoting initiation of an ACL IPP by best practice coaches - influenced by injury prevention (93%) followed by performance enhancement (36%). Small proportion of coaches (14%) acknowledged an awareness of the higher risk of ACL injury in female soccer players, which in turn led to their efforts in injury prevention. Others felt pressure from parents to implement a program (14%) and others reported being influenced because they knew someone (14%) who sustained an ACL injury as a result of soccer participation. Coaches asked where and how they first obtained information on ACL injuries in soccer and more specifically ACL injury prevention while at a conference (29%), from a team parent who was often involved in health care (21%) or their own playing experience (21%). The majority of coaches followed up structured learning experiences by looking for information on the internet. (Learning sources, behavioural capability, mastery experiences, self-efficacy). Likewise, the coaches felt that they would benefit from further education through web-based programs, DVDs and conferences (cues to action/action planning/learning efficacy/facilitators). 13/14 coaches stated soccer organizations should be responsible for disseminating information on ACL IP and most would personally advocate for ACL prevention education as requirement for coaching licence.

McGuine et al., (2013)

First stage (interviews to develop survey):

Several themes were identified to explore coaches' attitudes and behaviours regarding ankle injury prevention strategies. With regards to the use of braces, members of the panel indicated they would be concerned about the efficacy of ankle braces as well as the possible impacts braces could have on athletic performance or other lower extremity injuries. Concerns regarding ankle injury prevention programs included questioned efficacy, lack of awareness these programs existed, the ease of implementation, as well as the components (sports specificity) and formats (duration and days per week) for these programs.

Second stage (survey):

A total of 480 coaches from 299 high schools completed the survey. The primary finding was that ankle injury prevention strategies are underutilised in this study sample. A minority of coaches encouraged or required their players to use ankle braces. There was no association in PAB recommendations based on school enrolment, team sex, years of coaching experience or coaches' education level. The majority of the coaches surveyed thought ankle braces are effective in reducing the risk of ankle injuries but do not increase the risk of other lower extremity injuries or negatively impact performance. Despite these positive attitudes regarding ankle bracing, only one third of the coaches encouraged or required ankle brace use in their players. The rationale for this behaviour was not specifically measured. However, several coaches indicated in written comments that they did not feel comfortable recommending braces because they did not know which specific brand was best for their athletes. Other coaches indicated that they were unsure where to purchase ankle braces or were concerned about the associated costs ($40 to $60 per pair). Similar to low ankle brace use, a significant number of coaches also did not utilise an AIPEP, citing factors such as lack of time, space, awareness, and expertise to run these programs. With regards to time, several coaches indicated that they were only allotted 100 to 120 minutes of court time per day and therefore felt they could not give up to 10 to 20 minutes of that time to have the players perform an AIPEP. With regards to space

limitations, 1 high school athletic administrator from a large school in a rural setting commented that they only had 1 large wooden court available for all 6 of the school basketball teams (3 each for both the male and female teams), and as a result, each teams time spent on the court is tightly scheduled throughout the season. Almost half of the coaches who did not utilise an AIPEP cited a lack of time, awareness or expertise to use these programs. Coaches had a strong preference for the AIPEP format they would be willing to implement for their teams. There was no difference in utilisation of AIPEP based on school enrolment, team sex, years of coaching experience or coaches' education level. Coaches indicated that they would prefer programs that were specific to basketball in format and location, consisted of both injury prevention and performance enhancement components, were performed 2 to 3 days per week, lasted 5 to 15 minutes, and used minimal equipment.
Coach Education
Lawrence and colleagues (1997) conducted a study to describe the safe tackling knowledge, attitudes, and practices of Louisiana high school football players. They also followed up with coaches about the perceptions of using the safe tackling video with their players. The coaches from each school were contacted via telephone to participate in an interview about their use of Louisiana's safe-tackling video. Of the 11 coaches interviewed all had an awareness of the tape, however five coaches reported that they had not had the time to show their athletes the tape, the other six coaches expressed the concern that the video might make their players play less aggressive.
Gianotti, Hume and Tunstall (2010) conducted a descriptive study to assess the efficacy of integrating sport injury prevention into coach education within netball and soccer. The evaluation of the coach education programs focused on the quality and use of the course resource material, as well as assessing the extent to which coaches had incorporated injury prevention behaviours into their coaching methods and player practices. The sports specific programs were NetballSmart (www.netballsmart.co.nz) and SoccerSmart

(www.soccersmart.co.nz). NetballSmart was evaluated at the end of 2005, via a telephone survey of 217 coaches who had attended a NetballSmart course the same year. SoccerSmart was evaluated at the start of 2007, via an internet questionnaire completed by 71 coaches who had attended a SoccerSmart course in 2006. Uptake and application of information appeared to be high among coaches that undertook each of the respective courses. After attending the NetballSmart course, 89% of netball coaches reported they changed their coaching practices, with most (95%) reported using information from the course and passing on the information to players. Coaches indicated atleast 70% of their players had changed their stopping and landing techniques, dodging ability and cool-down/recover procedures as a result. Similarly, 96% of soccer coaches reported altering their coaching practices, with most changes relating to warm-up/cool-down and stretch (65%), technique (63%), fitness (60%) and nutrition/hydration (58%) practices. Overall, the authors noted that the integration of injury prevention content within coach education and resources may be a viable and effective strategy to help community coaches reduce the risk of injury among community level players.
Montelpare et al (2010) conducted an 8-week pilot intervention that introduced the “Play it Cool” safe hockey online program to a cohort of 24 volunteer coaches from different hockey leagues within Canada and the United States. The major objective of the Play it Cool program was to enable coaches at various levels competition to have the opportunity to enhance their understanding and approaches to delivery of safe hockey principles. Long term it was aimed at strengthening the minor hockey development programs by increasing awareness of high risk behaviours and providing alternatives to such behaviour to encourage in turn safe hockey players. The Play it Cool program consisted of seven learning modules which included (1) sportsmanship and ethics, (2) athlete centred/practice playing, (3) skating skills, (4) principles of play, (5) knowledge of the ice: playing location and area, (6) teaching checking as a skill, (7) controlling risk as a coach. The program was delivered entirely

online, with the assistance of a mentor/facilitator who participated in weekly discussion board dialogue.

Findings from post-program focus group indicated coaches' perceived strengths, weaknesses, perceived opportunities and perceived threats to the success of the online delivery of the Play It Cool program. The responses from coaches showed that the program was effective in raising the awareness of coaches to several issues of safe hockey (coaches' responses related more to the delivery rather than the evaluation of the content).

Coaches perceived many strengths of the online delivery of the Play It Cool program:

- Coaches felt that they were able to share their knowledge with a various range of coaches.. They found the feedback they received from each other was helpful, and considered that this may not have occurred if they had been in a traditional learning environment.
- Coaches felt that using a web-based discussion board provided a less intimidating environment where individuals could express themselves and where individuals who aren't quite vocal tend to not express themselves,
- Moving between the discussion boards, modules and drill was easy and user friendly,
- Videos were constructive and appropriate for content,
- Facilitators were valuable for keeping the conversation going (facilitators were essential in providing reminders of impending data),
- The content was helpful and coaches appreciated the information,
- the program emphasised the importance of safety education (reminded the learner of the Play It Cool value),
- coaches appreciated a program that was focused at them for continuing education and professional development.

Perceived weaknesses of the program by the coaches included:

- some drills being too complicated for the level of player (with lots of coaches working with younger players),
- Coaches reported they did not have enough time to use the drills from the website (despite

the perceived value),

- Coaches believed that the website could have included more information as well as more ways to use the information,
- Coaches believed the language was too difficult for children, but suitable for coaches who would have to interpret to children in their practices,
- Concepts like “no touch ice” were not understood by all members, so the discussion was less productive.
- Coaches believed the biomechanics education seemed too hard to understand and teach, so the coach brought in a power-skating coach,
- The coaches questioned the sustainability of the program and the need for information to be kept up to date from year to year.

Coaches reported perceived opportunities for improving the online coach education to include a user identification, ability to print drills from the website being more time efficient, equip the site with links so can forward to players, coaches felt the session finished too quickly without sufficient summation, current participants are future ambassadors and champions for the program, sustainability depends on providing more age appropriate materials and presenting materials in age categories, keep age group of players/athletes or coaches in mind when developing materials, make it mandatory education for all coaches.

Finally, perceived threats to the success of the online delivery of Play It Cool were assessed. It was mentioned by coaches that:

- a user identification be provided so that each user can identify others in their discussion-making person accountable for their comments,
- coaches did not want to waste time watching the media/animation,
- the site hadn’t been taken to the next level for coaches (not user friendly access),
- some coaches lost interest and had not time so did not complete,
- limited computer access and literacy,
- the value of group learning is decreased when some coaches didn’t participate,

• coaches didn't expect to give us much time as they did, coaches are volunteers and time commitment is demanding.
Mrazik, Bawani and Krol (2011) conducted a questionnaire with 178 minor (or junior) hockey coaches (head and assistant coaches) to assess how effective recent educational strategies promoting concussion safety literature, web-based information, and providing seminars across Canada have been. This involved a collaborative partnership approach between Hockey Canada, the Think First Foundation and Dr Tom Pashby Sports Safety Fund. The authors sought to understand (1) minor hockey coaches' current knowledge about concussion, (2) coaches perceptions about sport related concussion, (3) what sources of information on concussion coaches find helpful, and (4) how the information from educational promotion strategies has been translated into return-to-play practices. The high majority of the hockey coaches had limited knowledge about concussion; however they rated knowledge about concussion as being important in their role as a coach. Various sources of education about sport-concussion and the usefulness of these sources were reported among coaches. The sources included magazines/newspapers, the internet, other coaches, the family physician, emergency department, local hockey association, nonprofit sports society, and Alberta health. Magazines and newspapers (49.4%) were rated the most frequent source of information, followed by the internet (44.4%), other coaches (38.2%), and the family physician (36%). However, the family physician, internet and other sources (e.g. local hockey association, nonprofit sports society) were rated among coaches as the most useful. These finding reinforce the role of information sources when working with coaches and youth sports. The translation of knowledge about concussion using such methods may prove useful in improving the overall culture of coaching and prevention of concussion in minor hockey. The results suggested that most coaches had an awareness of risk factors and potential consequences of concussion. Most coaches recognised that the symptoms of concussion can be delayed, that concussion requires immediate removal from play, that concussions are considered a brain injury, and that athletes with a history of concussion are more likely to have subsequent concussions.

Mapping of determinants and influences of coach injury prevention behaviours (atheoretical studies only)

A number of theme factors related to the determinants of coach injury prevention behaviours were identified in coach injury prevention atheoretical studies. The following section will briefly outline and discuss some of these themes identified.

Coaches' behaviour, goals and intentions associated with injury prevention practices

In a broad sense, behaviour refers to the actions of individuals, groups and organisations as well as their determinants, correlates, and consequences, including social change, policy development and implementation, improved coping skills and enhanced quality of life (Glanz, 2008). It includes not only observable, overt actions but also mental events and feeling states that can be reported and measured (Glanz, 2008). In this context, preventive health behaviour is any activity undertaken by a coach for the purpose of preventing or detecting injury risk. Here, a number of examples have been drawn from the literature to outline the behaviour of a number of coaches:

"Coaches indicated that training programmes for fast bowlers were poorly defined and structured. There were no specific exercise regimes in flexibility, strength, speed and endurance. There was no individual exercise prescription or home exercises. The use of bowling prescription was also limited. One coach restricted net sessions to 45 minutes of bowling and another limited his young fast bowlers to five-over-spells. Technique alteration was used by all coaches, but not in an attempt to reduce injury risk. One actively encouraged a side-on technique for its other benefits. One stressed the importance of observing and altering techniques when players are young. No formal video analysis was being conducted, although coaches thought they were monitoring players themselves through continual observation". **(Bell, 1992)**

"Overall, coaches viewed themselves, the players, or the trainer as most responsible for players wearing mouthguards, not referees. The majority of coaches reported the team trainer was responsible for selecting the type of mouthguard used, despite most of them also reporting having a team dentist

(87%). Over 50% of coaches reported that all players wore mouthguards, but the quarterbacks were least likely to wear. Seventy-four percent of coaches reported they would warn the player of a violation themselves and thus reinforcing mouthguard behaviour use, yet only 26% felt the coach had the greatest influence on players wearing mouthguards". **(Ranalli, 1995)**

"Across all sports, 28% of coaches reported that some athletes used mouthguards regularly. 31% of coaches reported that they would not encourage mouthguard use".**(Berg, 1998)**

"The proportion of team coaches (intervention) who agreed that faceguards should be mandated increased by 30%. In spite of faceguards availability and apparent acceptability, overall faceguards are rarely employed". **(Danis, 2000)**

"Over 80% of coaches believed that mouthguards should be worn at all times by athletes, during practices and competitions, while 19% believed the use was only necessary during competition". **(Onyeaso, 2003)**

"Over 70% of coaches reported they believed mouthguards should be used by children and adolescents in sporting activities". **(Centibas, 2006)**

"The use of mouthguards in Turkey is rare in sports, and coaches among other key professionals need to encourage the use of mouthguards in training and competition". **(Duymus, 2009; Centibas, 2006)**

"On average, coaches facilitated stretching activities with their athletes 13 minutes prior to competition or training". **(Shehab, 2006)**

"Coaches did not routinely use plyometric training or agility drills on field, the weight room or during off-field practice sessions". **(Gilchrist, 2008)**

"The beliefs about training elements were consistent with the content of the observed coach-led training sessions, in that, the most time was spent on game-related skills training. Only one club had a structured warm up. In contrast to coaches' importance rating for endurance training for team performance, five teams did not include this in observed training sessions. Sprinting was observed at seven clubs, despite coaches generally indicating that they were unconvinced of its important. Little or no time was spent on balance, jump/landing and sidestepping techniques". (Twomey, 2008)

"The coaches' survey indicated that none of the athletes used mouthguards while participating in

sports. 35% of coaches reported they believed that university athletes should use mouthguards in sporting activities such as boxing and martial arts. No coaches reported influencing student's use of mouthguards, and most coaches (78%) indicate that they required more information about mouthguards". **(Duymus, 2009)**
Knowledge and perceptions of athletes risk and consequences of injury This factor identified refers to coaches' subjective perception of the risk of an athlete or player getting an injury condition and the coaches' beliefs about how serious an injury could be and its consequences. The following statements illustrate the concept of perceptions of threat/risk of athlete injury and its consequences: "About 72% of the coaches reported that at least one oral-facial injury was sustained among their athletes in a season. The most common injuries reported by over 80% of coaches were a cut lip, tongue or cheek. Other injuries included a bruised face, loose or broken teeth and broken bones". **(Berg, 1998)** "68.5% of all coaches had observed an orofacial injury". **(Persic, 2006)** "77.2% coaches observed an orofacial trauma". **(Centibus, 2006)** "64% had witnessed an orofacial trauma during sport activities; 35% of coaches believed that university athletes should use mouthguards in sports such as boxing and martial arts- belief that athletes playing certain sports are more susceptible". **(Duymus, 2009)** "The most common types of injuries observed included a crown fracture (n=23), a dislocation (n=5) and avulsion (n=4). About 50% of participants in this study were not aware that an avulsed tooth could be replanted". **(Lang, 2002)** "64% had witnessed an orofacial trauma during sport activities; 35% of coaches believed that university athletes should use mouthguards in sports such as boxing and martial arts, a belief that athletes playing certain sports are more susceptible". **(Duymus, 2009)** "About 50% reported they had a child who was hit in face, intervention coaches reported that facial

impacts were significant sources of injury and that faceguard use should be mandated". **(Danis, 2000)**

"About 58% of coaches reported observing that boxing was mostly associated with oro-facial injuries. Nearly half of all coaches surveyed reported observing over five injuries over the last 12 months (47% of injuries being soft tissue and 33% resulting in tooth loss). Coaches reported most injuries occurred in hockey and 32% were due to contact injuries, such as getting hit by a ball, stick or related hard object. Over 80% of injuries were related to non-use of protective equipment". **(Lehl, 2005)**

"In general, the findings suggested that coaches in this study had limited injury risk knowledge. While 71% of coaches identified the tackle as the game situation in which most injuries occur, only about half of coaches identified the upper limb of the tackler as the body part most likely to be injured in a tackle and one-quarter identified the lower limb of the ball carrier. Most coaches (97%) believed that previous injury increased the risk of re-injury". **(Carter, 2008)**

"The findings showed that coaches appeared to have a degree of awareness of back injury in general, and spondylolysis in particular. Only one coach believed that back injury was common among young cricketers that he coached, and none of the coaches believed that back injury accounted for a significant drop-out rate. However, all agreed that back injury now appears more common in the professional game that it was historically, and the modern-day fast bowler is more front-on, in position. Two coaches added that there were far fewer genuine swing bowlers around today and this was partly due to the bowling style adopted by modern-day fast bowlers". **(Bell, 1992)**

"Most coaches believed that PES does not increase the risk of injury and over 75% believed PES decreases the frequency of muscle cramps and strains, and ligament sprains. Almost 50% of coaches believed that PES could decrease the rate of dislocations, 44% believed neck injuries are reduced and almost a third stated PES would reduce fractures. A few also reportedly believed that PES increases the risk of joint dislocations". **(Shehab, 2006)**

PERCEIVED BENEFITS

Perceived benefits are often defined as one's belief in the efficacy of the advised action to reduce risk or seriousness of impact (Glanz, 2008). A number of coaches in the selected studies in this review believed that using certain preventive measure or strategies reduced the risk or seriousness of an injury condition.

Enhance adherence

Adherence was an important factor perceived by coaches in using preventive equipment and preventing injury in sport among their players/athletes. A number of studies reported that protective equipment rules and enforcement assisted with players using mouthguards. In a study conducted by **Ranalli (1995),** "*coaches reported that mouthguard rules and enforcement of rules was beneficial in determining player compliance and resulted in more frequent use*". In another study, **Danis (2000)** assessed the relative injury reduction effect and acceptability of face guards on baseball batters helmets. During the 1997 season, coaches, parents, and players among 238 youth league baseball teams in Central and Southern Indiana were asked to complete a pre and post-season questionnaire. Approximately one-half of the teams were supplied with faceguard helmets (intervention), other teams used at their discretion (comparison). *"The proportion of team coaches (intervention) who agreed that faceguards should be mandated increased by 30%".*

Reduce risk of injury

Using protective equipment and other preventive measures was perceived to be a benefit in reducing the risk of injury among coaches in a number of studies. Coaches perceived that mouthguards reduced the susceptibility and severity of concussion and oral-facial injuries ("*Headgear reduces the incidence or severity of concussion"* **(Pettersen, 2002)**; *"Most of the coaches believed the mouthguard was effective in protecting against oral-facial injuries"* (**Onyeaso, 2003)**; *"95.5% of coaches believed that mouthguards prevented orofacial injuries"* **(Centibus, 2006)**; *"76% believed that mouthguard prevented oral injuries"*. **(Duymus, 2009)**
Specialised exercise programs were also identified in two studies to reduce the risk of injury. **(Shehab, 2006)** found that *"Most coaches believed that pre-exercise stretching (PES) is beneficial, nearly all coaches believe that PES prevents a wide array of injuries. Almost 50% of coaches believed*

that PES could decrease the rate of dislocations, 44% believed neck injuries are reduced and almost a third stated PES would reduce fractures". **Twomey (2008)** reported that *"all coaches agreed they would implement specific training if it prevented LLI"*.

Improve performance or fitness component

Performance is a major factor in achieving outcomes for many sporting teams. This factor was highlighted in a number of studies as follows:

"All coaches agreed they would implement specific training if it both improve performance and prevented LLI". **(Twomey, 2008)**

"Improves conditioning, establishes a rhythm, and assists improve mental preparation". **(Shehab, 2006)**

Improve socialisation (or cohesion)

Half of the coaches believed that it also provided a socialisation aspect. (Shehab, 2006)

"The responses from coaches showed that the program was effective in raising the awareness of coaches to several issues of safe hockey (coaches' responses related more to the delivery rather than the evaluation of the content). Coaches' perceived many strengths of the online delivery of the Play It Cool program, such as, coaches felt that there was sharing within a community of knowledge, coaches found the feedback they received for each other was helpful, and may not have occurred of they had been in a traditional learning environment, coaches felt that using a web-based discussion board provided a less intimidating environment where individuals could express themselves and where individuals who aren't quite vocal tend to not express themselves, moving between the discussion boards, modules and drill was easy and user friendly, videos were constructive and appropriate for content, facilitators were valuable for keeping the conversation going (facilitators were essential in providing reminders of impending data), content was helpful, coach appreciated the information, the program emphasised the importance of safety education (reminded the learner of the Play It Cool value), coaches appreciated some of the aspects of creating a program continuing education and professional development". (Montelpare, 2010)

PERCEIVED BARRIERS

The potential negative aspects or perceived barriers of particular preventive measures were explored among coaches in this review. Such aspects may act as impediments to undertaking a recommended preventive behaviour. According to Janz and Becker (Janz, 2002) a kind of non-conscious, cost-benefit analysis occurs, wherein a coach, for example, may weigh a preventive measures expected effectiveness against perceptions that it may be expensive, dangerous, unpleasant, inconvenient, and time-consuming.

Cost

Many coaches perceived that the cost of protective equipment, such as, headgear and mouthguards can often hinder their decision or behaviour to reinforce the regular use of preventive measures among their athletes/players, despite the perceived benefits of the particular protective equipment. In a study conducted by **Pettersen (2002)** assessing Canadian rugby players and coaches' attitudes to the use of protective headgear to prevent concussion *"coaches were worried that the cost of playing rugby would increase"*. Similarly, high school coaches in further studies indicated "*60% of coaches stated they would encourage mouthguard use if free*". **(Berg, 1998)** and "*the choice of mouthguard by coaches for their athletes was the quality of the oral protection, followed by the cost*" **(Onyeaso, 2003)**.

Perceived Lack of Time

Coaches often cited lack of time as a barrier to utilising preventive behaviours or undertaking appropriate training (e.g., online coach education program) to improve their behavioural capability in implementing preventive measures in their training for players. **Montelpare (2010)** in their study on evaluating an online concussion program found time factors to be a concern among coaches. Some of the coaches comments were: (1) *"did not have enough time to use the drills from the website, despite the perceived value"*, (2) *"coaches did not want to waste time watching the media/animation and the* *site hadn't been taken to the next level for coaches (not user friendly access)"*, (3) *some coaches lost interest and did not have time so did not complete"* and (4) *coaches didn't expect to give us much time as they did, coaches are volunteers and time commitment is demanding"*. It appears that time factors as a barrier to the concussion program and its ongoing success may also be associated to other factors such as the program being enjoyable, satisfying, meaningful and convenient. Coaches' expectations about the program also appear to be linked to time as a barrier.

In another study, **Shehab (2006)** conducted a study of to assess the knowledge, attitudes and practices of 71 high school head coaches regarding pre-exercise stretching. Findings showed that using pre-exercise stretching was potentially disruptive to some coaches' training schedules: "*Coaches' acknowledged that pre-exercise stretching takes times away from other potential forms of preparation. The majority of coaches however reported that this was not an important barrier"* **(Shehab, 2006).** This suggests that other forms of training in a coaches' training schedule may be more important, this could however be situational and dependent on other factors within related to the individual coach and/or training environment.

Lack of social support (encouragement/reinforcement towards players/athletes)

Social support is a key aspect of one's social environment. In this context, social support refers to a coaches' favourable (or not so favourable) attitude towards their players or athletes' involvement in using a preventive measure or involvement in an injury prevention program. Coach interactions with their athletes and others may influence preventive activities in many ways, for example, attendance at training sessions, adherence to structured exercise programs or improve preventive behaviour. The following statement by high school athletic coaches in the United States provides an illustration of coach's attitudes and lack of social support towards mouthguard equipment use among their players: *"Thirty-one percent of coaches reported they would not encourage mouthguard use"* (Berg, 1998). In this study **(Berg, 1998)** however, coaches would encourage mouthguard use if they were "free", suggesting the cost of a mouthguard is perhaps more of a barrier towards encouraging mouthguard use than social support. The fact that mouthguards were not mandated may also be a reflection of coaches' behaviour, this was however not substantiated in the findings of the study.

Lack of group cohesion (or peer support/participation)

Group cohesion is the force bringing group members closer together. Cohesiveness has two dimensions: emotional (or personal) and task-related. The emotional aspect of cohesiveness, which was studied more often, is derived from the connection that members feel to other group members and to their group as a whole. That is, how much do members like to spend time with other group members? Do they look forward to the next group meeting? Task-cohesiveness refers to the degree to which group members share group goals and work together to meet these goals. That is, is there a feeling that the group works smoothly as one unit or do different people pull in different directions? As an example, group cohesion appeared to impact on group learning in a study conducted by **Montelpare (2010)** due to coaches not participating or lacking cohesion*"the value of group learning is decreased when some coaches don't participate"* **(Montelpare, 2010).** The main factors that have been shown to influence group cohesiveness are: members' similarity, group size, entry difficulty, group success and external competition and threats. These could have been some of the factors that were associated with this particular barrier. Often, these factors work through enhancing the identification of the individual with the group she/he belongs to as well as their beliefs of how the group can fulfill their personal needs. These factors also contribute to positive effects on the group such as group member satisfaction, an increased amount of cooperation and conformity and members within the group are able to influence each other.

Self-motivation

Coaches' self-motivation appeared lacking in some instances. For example, **Montelpare (2010)** reported *"some coaches lost interest"* in continuing with an online educational concussion program for coaches. It appears coaches' commitment and dedication to maintain the program may have been related to them being volunteers and perhaps had other aspects of life to contend with. Factors such as engagement and time may also be associated with lack of self-motivation.

Type of equipment (Physical environment)

Coaches' perception about the use of particular types of personal protective equipment by their players was identified as a barrier to preventive behaviour among coaches. In a study conducted by Pettersen and colleagues **(Pettersen, 2002):** *"five of the nine coaches did not think the use of protective headgear reduces the incidence or severity of concussions, one coach was undecided and three believed that headgear was effective. Some coaches that did not believe headgear was effective in preventing concussion suggested its use could potentially lead to more concussion as the player may: "have a false sense of security", "learn to lead with their heads"; or even take a "kamikaze approach". They were concerned that padding in rugby may evolve to that currently used in American football. Apart from potentially leading to more injuries, the coaches were worried that the cost of playing rugby would also increase"* **(Pettersen, 2002).** The quality of personal protective equipment for oral protection was also mentioned in another study as an important barrier **(Onyeaso, 2003).**

Type of training (characteristics/structure of preventive activity)

The type of training (or characteristics/structural factors of preventive activity) is an important consideration that was identified in some of the coach studies. For example, coaches' reported perceived weaknesses of an online program included some drills being too complicated. This was often associated with their belief that they would be too advanced for the level of player (Montelpare, 2010). This suggests that it is important for a coach to link the type of training they deliver to the readiness of their players/athletes. A few also reported in another study they believed that pre-exercise stretching increased the risk of joint dislocations". **(Shehab, 2006)**

Lack of skill or education

Lack of skill or education was identified as a further barrier among coaches. For example, in Montelpare and colleagues study (Montelpare, 2010), they reported the coaches indicated that "the biomechanics education seemed too hard to understand and teach, so the coach brought in a power-skating coach" **(Montelpare, 2010).**

Self-efficacy/confidence and control in implementing preventive measures

Coaches' confidence and control (also self-efficacy) is the confidence a person feels about performing a particular activity, including the confidence in overcoming barriers to performing a specific behaviour. Bandura and colleagues (Bandura, 2001, 2000) proposed that self-efficacy is an important prerequisite for behaviour change because it affects how much effort is invested in a given task and what level of performance is attained. For example, a coaches' confidence in their ability to take action, or implement a preventive measures, such as a specialised exercise program, can impact upon how well their athletes perform the behaviour. The following statement provides an illustration related to coaches' perceived self-efficacy it her ability to influence players wearing mouthguards:

"Overall, coaches viewed themselves, the players, or the trainer as most responsible for players wearing mouthguards, not referees. Yet only 26% felt the coach had the greatest influence on players wearing mouthguards". **(Ranalli, 1995)**

Attitudes towards the behaviour

Attitudes are determined by an individual's belief about outcomes or attributes of a behaviour weighted by evaluations of those outcomes or attributes {{543 Ajzen, I. 2010}}. For example, in a study conducted with high school coaches it was found that *"Over 80% of coaches believed that mouthguards should be worn at all times by athletes, during practice and competitions, while 19% believed that use was only necessary during competitions"* **(Onyeaso, 2003).** Thus, it appears most coaches in this study hold strong beliefs that positively valued outcomes will result from performing the behaviour will have a positive attitude toward the behaviour.

POSSIBLE STUDIES TO BE INCLUDED IN REVIEW (n=5)

McKay* (June 2014, Online first) At baseline, 62.8% (95% CI 48.4% to 77.3%) of coaches and 75.8% (95% CI 71.5% to 80.1%) of players considered 'inadequate warm-up' a risk factor for injury. There was no effect of delivery method (OR=1.1; 95% CI 0.8 to 1.5) or adherence (OR=1.0; 95% CI 0.9 to 1.1) on this belief. At baseline, 13.8% (95% CI 1.3% to 26.4%) of coaches believed a warm-up could prevent muscle injuries, but none believed it could prevent knee and ankle injuries. For players, 9.7% (95% CI 6.1% to 13.3%), 4.7% (95% CI 2.1% to 7.3%) and 4.7% (95% CI 2.1% to 7.3%) believed a warm-up would prevent muscle, knee and ankle injuries, respectively. Years of playing experience were negatively associated with high adherence for coaches (OR=0.93; 0.88 to 0.99) and players (OR=0.92; 0.85 to 0.98).
Frank et al., (2014) The injury prevention workshop increased coaches' attitudes toward conducting a program at the beginning of practice ($p < 0.05$), substituting the program for a warm-up prior to practice ($p < 0.05$), and improving player cutting and landing technique by implementing the program ($p < 0.05$). The injury prevention program workshop increased coaches' perceived behavioral control; feeling more comfortable in their ability to teach their team a program ($p < 0.05$), and more confident leading a program if given instructions ($p < 0.05$). The injury prevention program workshop increased coaches' intent to implement a program the next season ($p < 0.05$), to implement a program for 15 min ($p < 0.05$), and 20 min ($p < 0.05$) prior to the start of a training session. Only 53% of the club's teams implemented the injury prevention program, with implementers demonstrating high variability in program fidelity.
Newton et al., (2014) Application of an extended TPB model identified several factors associated with coaches and sport trainers intended use of the AFL/NRL concussion guidelines, including self-efficacy and personal norms. Based on coaches and sport trainers salient beliefs, specific issues were identified inhibiting the intended use of concussion guidelines, including time and resource complains and perceived

inexperience and unfamiliarity in using the guidelines. These finding provide useful insights into the development of interventions aimed at encouraging the use of the AFL/NRL concussion guidelines.
Donaldson et al, (2014) Community rugby coaches in regional New South Wales, Australia. Neck-injury prevention program –Mayday Safety Procedure (potentially dangerous scrum situations). Step 5 of intervention mapping was used to plan strategies to enhance MSP adoption and implementation. Coaches were identified as the primary MSP adopters and implementers within a system including administrators, players and referees. A local advisory group was established to ensure context relevance. Performance objectives (eg, attend MSP training for coaches) and determinants of adoption and implementation behaviour (eg, knowledge, beliefs, skills and environment) were identified, informed by Social Cognitive Theory. Adoption and implementation matrices were developed and change-objectives for coaches were identified (eg, skills to deliver MSP training to players). Finally, intervention methods and specific strategies (eg, coach education, social marketing and policy and by-law development) were identified based on advisory group member experience, evidence of effective coach safety behaviour-change interventions and Diffusion of Innovations theory. This is the first published example of a systematic approach to plan injury prevention programme diffusion in community sports. The key strengths of this approach were an effective researcher–practitioner partnership; actively engaging local sports administrators; targeting specific behaviour determinants, informed by theory and evidence; and taking context-related practical strengths and constraints into consideration. It was mentioned evaluation of the outcome of implementing this diffusion plan in a single region during the 2011 rugby season to see if investment in the strategic planning process for diffusion of the MSP was warranted.
Kroshus et al., (2014) All teams received concussion education material; however, content and delivery varied. Rates of material recall differed by delivery format. Considering all teams together, there were no significant

improvements in knowledge and only a very small decrease in intention to continue playing while experiencing symptoms of a concussion. Pre-education and post-education, there were significant between-team differences in attitudes towards concussion reporting and behavioural intention.

The NCAA's general education mandate was divergently enacted; it did not significantly change the constructs of interest nor did it mitigate the pre-education team differences in these constructs. Existing educational materials should be evaluated, theory and evidence-driven materials developed, and mandates extended to, at a minimum, recommend materials found to be effective in changing concussion-reporting behaviour.

Appendix G: Coast Preseason and Postseason Surveys 2007 and 2008

Coaching Aspirations

19) What are your coaching aspirations/ambitions? (e.g. do you hope to coach at a representative level or any level higher than you currently coach)

This season

The next 2 years

The next 5 years

Thank you again for your cooperation in completing this survey.

UNIVERSITY of BALLARAT Australia

PAFIX
PREVENTING AUSTRALIAN FOOTBALL INJURIES THROUGH EXERCISE

THE UNIVERSITY OF WESTERN AUSTRALIA

Office Use Only
ID:____/_____/_____
Today's date: ___/___/07

PAFIX PRE-SEASON COACH SURVEY

Thank you for participating in this survey about your coaching experience and knowledge /attitudes about lower limb injuries in football. In this survey, the lower limb refers to hip, knee, ankle, and foot joints and all soft tissue (e.g. muscles, tendons, ligaments) around these joints.

Please tick the appropriate box or circle a selection to respond to questions with given options or write your answers in words or numbers where lines are provided.

Personal Details

1) Name:

2) Club:

3) Coaching Position:

4) Date of Birth:

5) Highest current coaching qualification:

Title	Awarding Body	Year Obtained

6) Have you ever played Australian football yourself?

Yes ☐ — How many years did you play?
— What was the highest level you played?

No ☐

7) How many years have you been coaching football (includes all levels)?

8) What is the highest level you have coached football at?

Coaching Information

9) What is your main coaching focus with this team for the next year?

10) **Do you plan your training sessions?**

Yes ☐ No ☐

If you answered No go to Question 16*. If you answered Yes continue from Question 11.*

11) **How many weeks in advance do you plan your training sessions?** ☐

12) **Do you have a formal training plan for this season?**

Yes ☐ No ☐

13) **Do you have a formal training plan for each session?**

Yes ☐ No ☐

14) **Please specify if your training plan is based on any of the common training principles (e.g. specificity, overload, progression, tapering, etc)?**

15) **Is your training schedule periodised (i.e. divided into different cycles or periods)?**

Yes ☐ No ☐

If yes, please give brief details on the length of the cycles and the components within each cycle.

Lower Limb Injuries

16) **On a scale of 1 to 5 (1 = no importance, 5 = utmost importance), how important do you think each of the following are?**

Please circle the appropriate response for each category .

	Your team's training schedule 1 2 3 4 5	Your team's performance 1 2 3 4 5	Preventing lower limb injuries 1 2 3 4 5
Warm up run	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Warm up stretches	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Ball handling skills	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Kicking skills	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Tackling skills	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Ball disposal skills	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Marking skills	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Body contact skills	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Performing game set-plays	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Sprint sessions	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Weights/resistance training	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Jumping/landing training	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Changing direction/side-stepping training	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Balance training (eg - using a wobble board)	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Endurance/fatigue training	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Cool down run/stretches	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5

17) **Please circle the appropriate response for each of the following statements.**

	Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree
1. Players are more at risk of lower limb injuries now than 10 years ago.	1	2	3	4	5
2. Players are responsible for preventing their own lower limb injuries.	1	2	3	4	5
3. Lower limb injuries cannot be prevented.	1	2	3	4	5
4. Lower limb injuries are not a problem for my team.	1	2	3	4	5
5. It is important for players to attend training sessions if they want to remain injury free.	1	2	3	4	5
6. I would implement specific types of training in my sessions if they were shown to improve football performance in my players.	1	2	3	4	5
7. Lower limb injuries negatively influence game performance and end of season results for my team.	1	2	3	4	5
8. Players with lower limb injuries are usually not available to play for one or more weeks.	1	2	3	4	5
9. Improving team performance is important when planning my training sessions.	1	2	3	4	5
10. I would implement specific types of training in my sessions if they were shown to prevent lower limb injuries in my players.	1	2	3	4	5
11. Pre-season training is important for preventing lower limb injuries in my players during the season.	1	2	3	4	5
12. Incorporating lower limb injury prevention strategies is important when I plan my training sessions.	1	2	3	4	5
13. I am the best source of information about how to prevent lower limb injuries for my players.	1	2	3	4	5
14. Players are more at risk of lower limb injuries when playing on hard/dry grounds.	1	2	3	4	5
15. It is important for players to attend training sessions if they want to play in games.	1	2	3	4	5
16. It is important for me to have a current knowledge of lower limb injury prevention strategies.	1	2	3	4	5
17. I would implement specific types of training in my sessions if they were shown to improve football performance and prevent lower limb injuries in my players.	1	2	3	4	5

18) **What specific lower limb injury prevention strategies do you currently use with your team and why? If you do not use any specific strategies please state this.**

Coaching Aspirations

19) What are your coaching aspirations/ambitions? (e.g. do you hope to coach at a representative level or any level higher than you currently coach)

This season

The next 2 years

The next 5 years

Thank you for your cooperation in completing this survey.

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ID:____________
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PAFIX PRE-SEASON COACH SURVEY

Thank you for participating in this survey about your coaching experience and knowledge /attitudes about lower limb injuries in football. In this survey, the lower limb refers to hip, knee, ankle, and foot joints and all soft tissue (e.g. muscles, tendons, ligaments) around these joints.

Please tick the appropriate box or circle a selection to respond to questions with given options or write your answers in words or numbers where lines are provided.

Personal Details

1) First name: ☐ Last name: ☐

2) Club: ☐

3) Coaching Position: Title ☐

4) What team do you coach at this football club? ☐

5) Date of Birth: ☐

6) Highest current football coaching qualification:

Title	Awarding Body	Year Obtained

7) Have you ever played Australian football yourself?

Yes ☐ – How many years did you play? ☐
– What was the highest level you played? ☐

No ☐

8) How many years have you been coaching football (includes all levels)? ☐

9) What is the highest level you have coached football at? ☐

Coaching Information

10) What is your main coaching focus with this team for the next year?

11) Do you plan your training sessions?

Yes ☐ No ☐

If you answered No go to Question 16. *If you answered Yes continue from Question 11.*

12) Do you have a formal training plan for this season?

Yes ☐ No ☐

13) Do you have a formal training plan for each session?

Yes ☐ No ☐

14) Please specify if your training plan is based on any of the common training principles (e.g. specificity, overload, progression, tapering, etc)?

____

____

____

15) Is your training schedule periodised (i.e. divided into different cycles or periods)?

Yes ☐ No ☐

If yes, please give brief details on the length of the cycles and the components within each cycle.

____

____

____

Lower Limb Injuries

16) On a scale of 1 to 5 (1 = no importance, 5 = utmost importance), how important do you think each of the following are?

Please circle the appropriate response for each category .

	Your team's training schedule 1 2 3 4 5	Your team's performance 1 2 3 4 5	Preventing lower limb injuries 1 2 3 4 5
Warm up run	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Warm up stretches	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Ball handling skills	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Kicking skills	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Tackling skills	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Ball disposal skills	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Marking skills	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Body contact skills	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Performing game set-plays	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Sprint sessions	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Weights/resistance training	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Jumping/landing training	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Changing direction/side-stepping training	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Balance training (eg - using a wobble board)	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Endurance/fatigue training	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Cool down run/stretches	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5

17) Please circle the appropriate response for each of the following statements.

	Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree
1. Players are more at risk of lower limb injuries now than 10 years ago.	1	2	3	4	5
2. Players are responsible for preventing their own lower limb injuries.	1	2	3	4	5
3. Lower limb injuries cannot be prevented.	1	2	3	4	5
4. Lower limb injuries are not a problem for my team.	1	2	3	4	5
5. It is important for players to attend training sessions if they want to remain injury free.	1	2	3	4	5
6. I would implement specific types of training in my sessions if they were shown to improve football performance in my players.	1	2	3	4	5
7. Lower limb injuries negatively influence game performance and end of season results for my team.	1	2	3	4	5
8. Players with lower limb injuries are usually not available to play for one or more weeks.	1	2	3	4	5
9. Improving team performance is important when planning my training sessions.	1	2	3	4	5
10. I would implement specific types of training in my sessions if they were shown to prevent lower limb injuries in my players.	1	2	3	4	5
11. Pre-season training is important for preventing lower limb injuries in my players during the season.	1	2	3	4	5
12. Incorporating lower limb injury prevention strategies is important when I plan my training sessions.	1	2	3	4	5
13. I am the best source of information about how to prevent lower limb injuries for my players.	1	2	3	4	5
14. Players are more at risk of lower limb injuries when playing on hard/dry grounds.	1	2	3	4	5
15. It is important for players to attend training sessions if they want to play in games.	1	2	3	4	5
16. It is important for me to have a current knowledge of lower limb injury prevention strategies.	1	2	3	4	5
17. I would implement specific types of training in my sessions if they were shown to improve football performance and prevent lower limb injuries in my players.	1	2	3	4	5

18) What specific lower limb injury prevention strategies do you currently use with your team and why? If you do not use any specific strategies please state this.

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Office Use Only
ID:_______________
Today's date: ___/___/07

PREVENTING AUSTRALIAN FOOTBALL INJURIES THROUGH EXERCISE

PAFIX POST-SEASON COACH SURVEY

Thank you for participating in the PAFIX Project this year. Now that it is the end of the football season, we would like to know from a coaching perspective what you thought about the "PAFIX Warm-Up Program" and if you thought it assisted your football team during the 2007 season.

Instructions

- It is important you answer all questions as honestly as possible.
- Where there is more than one answer please tick only the best option.
- Where there are lines please write your answer in words or numbers.
- When we mention lower limb we are referring to ***joints*** from the hip, downwards on your body (eg. hip, knee, shins, ankles, feet) and ***soft tissues*** surrounding these joints (eg. muscles such as - thighs, hamstrings, calves; and also

Personal Details

1) Name:

2) Club:

3) Coaching Position:

4) Date of Birth:

Coaching Information

5) Have you undergone any formal coach education this year?

Title	Awarding Body	When Obtained

6) What was your main coaching focus with your team over the 2007 football season?

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7) What will be your main coaching focus for the 2008 football season?

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Lower Limb Injuries

8) On a scale of 1 to 5 (1 = no importance, 5 = utmost importance), how important do you think each of the following skills and training components are?

Please circle the appropriate response for each category .

Skills	For your team's training schedule Importance Least ⟷ Most	For your team's performance Importance Least ⟷ Most	For preventing lower limb injuries Importance Least ⟷ Most
Warm up run	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Warm up stretches	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Ball handling skills	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Kicking skills	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Tackling skills	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Ball disposal skills	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Marking skills	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Body contact skills	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Performing game set-plays	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Sprint sessions	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Weights/resistance training	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Jumping/landing training	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Changing direction/side-stepping training	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Balance training (eg - using a wobble board)	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Endurance/fatigue training	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Cool down run/stretches	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
	Importance Least ⟷ Most	Importance Least ⟷ Most	Importance Least ⟷ Most

Questions continue on the next page...

9) Please circle the appropriate response for each of the following statements.

	Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree
1. Players are more at risk of lower limb injuries now than 10 years ago.	1	2	3	4	5
2. Players are responsible for preventing their own lower limb injuries.	1	2	3	4	5
3. Lower limb injuries cannot be prevented.	1	2	3	4	5
4. Lower limb injuries are not a problem for my team.	1	2	3	4	5
5. It is important for players to attend training sessions if they want to remain injury free.	1	2	3	4	5
6. I would implement specific types of training in my sessions if they were shown to improve football performance in my players.	1	2	3	4	5
7. Lower limb injuries negatively influence game performance and end of season results for my team.	1	2	3	4	5
8. Players with lower limb injuries are usually not available to play for one or more weeks.	1	2	3	4	5
9. Improving team performance is important when planning my training sessions.	1	2	3	4	5
10. I would implement specific types of training in my sessions if they were shown to prevent lower limb injuries in my players.	1	2	3	4	5
11. Pre-season training is important for preventing lower limb injuries in my players during the season.	1	2	3	4	5
12. Incorporating lower limb injury prevention strategies is important when I plan my training sessions.	1	2	3	4	5
13. I am the best source of information about how to prevent lower limb injuries for my players.	1	2	3	4	5
14. Players are more at risk of lower limb injuries when playing on hard/dry grounds.	1	2	3	4	5
15. It is important for players to attend training sessions if they want to play in games.	1	2	3	4	5
16. It is important for me to have a current knowledge of lower limb injury prevention strategies.	1	2	3	4	5
17. I would implement specific types of training in my sessions if they were shown to improve football performance and prevent lower limb injuries in my players.	1	2	3	4	5

10) Will you use any specific lower limb injury prevention strategies next season?

☐ Yes ☐ No

11) Would you undertake any further coaching education to gain knowledge in injury prevention strategies to prevent injuries in your team if this was available to you?

☐ Yes ☐ No

Questions continue on the next page...

PAFIX Warm-Up Program Coach Feedback

We would like you to tell us what you thought about the "PAFIX Warm-Up Program" that was conducted this season.
The PAFIX Warm-Up Program refers to the program administered by the University Trainers.

12. Do you think the "PAFIX Warm-Up Program" benefited your team in the 2007 football season in the following ways:

	Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
Improvements in performance	☐	☐	☐	☐	☐
Reduction in risk of injury	☐	☐	☐	☐	☐
It increased team enjoyment of the game	☐	☐	☐	☐	☐
It improved team bonding	☐	☐	☐	☐	☐
It improved team fitness	☐	☐	☐	☐	☐
It made team training more enjoyable	☐	☐	☐	☐	☐

13) Compared to training in previous seasons, do you think this year's "PAFIX Warm-Up Program" was:

	Yes	No	Same	Don't Know
Of more benefit to team performance	☐	☐	☐	☐
Of more benefit to player performance	☐	☐	☐	☐
More relevant to the game	☐	☐	☐	☐
Harder	☐	☐	☐	☐
More enjoyable	☐	☐	☐	☐
More of a physical challenge for players	☐	☐	☐	☐
Better at preventing injury	☐	☐	☐	☐
Boring for players	☐	☐	☐	☐
Not challenging enough	☐	☐	☐	☐
Too time consuming	☐	☐	☐	☐
Too much effort	☐	☐	☐	☐

14) Overall, how would you rate the "PAFIX Warm Up Program" for your players?
☐ High intensity ☐ Moderate intensity ☐ Low intensity

15) Were the PAFIX training Warm Up sessions:
☐ Too long ☐ Too short ☐ Just right ☐ Don't know

16) Was the variety of exercises in the "PAFIX Warm Up Program":
☐ Good ☐ Adequate ☐ Poor ☐ Don't know

17) Was the timing of changes to the "PAFIX Warm Up Program" (e.g. every 3-5 weeks):
☐ Too long ☐ Too short ☐ Just right ☐ Don't know

18) Over the 2007 football season, did you see improvements in the following fitness parameters in your players participating in the "PAFIX Warm-Up Program" *(please circle your response)*

Strength	Fitness	Endurance	Agility	Balance	Speed
Yes	Yes	Yes	Yes	Yes	Yes
No	No	No	No	No	No
Don't Know	Don't Know	Don't Know	Don't Know	Don't Know	Don't Know

19. If you had a formal training plan for the season, did the "PAFIX Warm-Up Program" integrate well with your season plan?

☐ Yes ☐ No ☐ Not applicable

20. If you had a formal training plan for each session, did the "PAFIX Warm-Up Program" integrate well with your session plans?

☐ Yes ☐ No ☐ Not applicable

21. With the integration of the PAFIX program do you think you will modify or change the common training principles that you normally use?

☐ Yes ☐ No

22. Do you think you will utilise training methods employed in the PAFIX Warm-Up Program in season 2008?

☐ Yes ☐ No

23. How useful did you find the PAFIX results (e.g. fitness test results) provided to players:

☐ Very useful ☐ Somewhat useful ☐ Undecided ☐ Not very useful ☐ Not useful

24) From your perspective did the PAFIX trainer:

	Always	Often	Sometimes	Rarely	Never
a) provide interactive sessions?	☐	☐	☐	☐	☐
b) provide encouraging feedback to players?	☐	☐	☐	☐	☐
c) show enthusiasm and energy?	☐	☐	☐	☐	☐
d) demonstrate knowledge of training drills?	☐	☐	☐	☐	☐
e) show concern for player safety?	☐	☐	☐	☐	☐
f) keep the coaching team well informed?	☐	☐	☐	☐	☐

25) Did you encourage players to participate in the "PAFIX Warm-Up Program"?

☐ Always ☐ Often ☐ Sometimes ☐ Rarely ☐ Never

Why?

26) Did you feel that it was important to encourage players to participate in the "PAFIX Warm-Up Program"?

☐ Always ☐ Often ☐ Sometimes ☐ Rarely ☐ Never

Why?

27) Do you think the "PAFIX Warm-Up Program" could be improved in any way?

☐ No ☐ Don't Know ☐ Yes

If yes, how?

28) If you had the opportunity would you agree to players and/or your club participating in similar training for football in the future?

☐ No ☐ Don't Know ☐ Yes

Please explain why you answered the way you did.

29) Is there anything else you would like to tell us about the "PAFIX Warm-Up Program"?

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Thank you for your participation in the completion of the survey and your involvement in the PAFIX Warm-Up Program with your club.

PAFIX PREVENTING AUSTRALIAN FOOTBALL INJURIES THROUGH EXERCISE

The University of Western Australia

Office Use Only

ID:______________

Today's date: ___/___/08

PREVENTING AUSTRALIAN FOOTBALL INJURIES THROUGH EXERCISE

THE UNIVERSITY OF WESTERN AUSTRALIA

PAFIX POST-SEASON COACH SURVEY

Thank you for participating in the PAFIX Project this year. Now that it is the end of the football season, we would like to know from a coaching perspective what you thought about the PAFIX Warm-Up Program and if you thought it assisted your football team during the 2008 season.

Instructions

- It is important you answer all questions as honestly as possible.
- Where there is more than one answer please tick only the best option.
- Where there are lines please write your answer in words or numbers.
- When we mention lower limb we are referring to ***joints*** from the hip, downwards on your body (eg. hip, knee, shins, ankles, feet) and ***soft tissues*** surrounding these joints (eg. muscles such as - thighs, hamstrings, calves; and also tendons and ligaments).

Personal Details

1) Name:

2) Club:

3) Coaching Position: **Are you also a player for your club?** **Yes** ☐ **No** ☐

4) Date of Birth:

Coaching Information

5) Have you undergone any formal coach education this year?

Title	Awarding Body	When Obtained

6) What was your main coaching focus with your team over the 2008 football season?

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7) What will be your main coaching focus for the 2009 football season?

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Lower Limb Injuries

8) On a scale of 1 to 5 (1 = no importance, 5 = utmost importance), how important do you think each of the following skills and training components are?

Please circle the appropriate response for each category .

Skills	For your team's training schedule Importance Least ⟷ Most	For your team's performance Importance Least ⟷ Most	For preventing lower limb injuries Importance Least ⟷ Most
Warm up run	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Warm up stretches	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Ball handling skills	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Kicking skills	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Tackling skills	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Ball disposal skills	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Marking skills	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Body contact skills	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Performing game set-plays	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Sprint sessions	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Weights/resistance training	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Jumping/landing training	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Changing direction/side-stepping training	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Balance training (eg - using a wobble board)	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Endurance/fatigue training	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
Cool down run/stretches	1 2 3 4 5	1 2 3 4 5	1 2 3 4 5
	Importance Least ⟷ Most	Importance Least ⟷ Most	Importance Least ⟷ Most

Questions continue on the next page...

9) Please circle the appropriate response for each of the following statements.

	Strongly Disagree	Disagree	Uncertain	Agree	Strongly Agree
1. Players are more at risk of lower limb injuries now than 10 years ago.	1	2	3	4	5
2. Players are responsible for preventing their own lower limb injuries.	1	2	3	4	5
3. Lower limb injuries cannot be prevented.	1	2	3	4	5
4. Lower limb injuries are not a problem for my team.	1	2	3	4	5
5. It is important for players to attend training sessions if they want to remain injury free.	1	2	3	4	5
6. I would implement specific types of training in my sessions if they were shown to improve football performance in my players.	1	2	3	4	5
7. Lower limb injuries negatively influence game performance and end of season results for my team.	1	2	3	4	5
8. Players with lower limb injuries are usually not available to play for one or more weeks.	1	2	3	4	5
9. Improving team performance is important when planning my training sessions.	1	2	3	4	5
10. I would implement specific types of training in my sessions if they were shown to prevent lower limb injuries in my players.	1	2	3	4	5
11. Pre-season training is important for preventing lower limb injuries in my players during the season.	1	2	3	4	5
12. Incorporating lower limb injury prevention strategies is important when I plan my training sessions.	1	2	3	4	5
13. I am the best source of information about how to prevent lower limb injuries for my players.	1	2	3	4	5
14. Players are more at risk of lower limb injuries when playing on hard/dry grounds.	1	2	3	4	5
15. It is important for players to attend training sessions if they want to play in games.	1	2	3	4	5
16. It is important for me to have a current knowledge of lower limb injury prevention strategies.	1	2	3	4	5
17. I would implement specific types of training in my sessions if they were shown to improve football performance and prevent lower limb injuries in my players.	1	2	3	4	5
18. A serious lower limb injury could have a negative impact on a player's life.	1	2	3	4	5
19. A serious lower limb injury could stop a player from undertaking their day-to-day employment.	1	2	3	4	5
20. A player's chance of getting a lower limb injury whilst playing football is high.	1	2	3	4	5

10) Will you use any specific lower limb injury prevention strategies next season?

Yes ☐ No ☐ Don't know ☐

11) Would you undertake any further coaching education to gain knowledge in injury prevention strategies to prevent injuries in your team if this was available to you?

Yes ☐ No ☐ Don't know ☐

PAFIX Warm-Up Program Coach Feedback

We would like you to tell us what you thought about the PAFIX Warm-Up Program that was conducted this season.
The PAFIX Warm-Up Program refers to the program administered by the University Trainers.

12. Do you think the PAFIX Warm-Up Program benefited your team in the 2008 football season in the following ways:

	Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree
Improvements in performance	☐	☐	☐	☐	☐
Reduction in risk of injury	☐	☐	☐	☐	☐
It increased team enjoyment of the game	☐	☐	☐	☐	☐
It improved team bonding	☐	☐	☐	☐	☐
It improved team fitness	☐	☐	☐	☐	☐
It made team training more enjoyable	☐	☐	☐	☐	☐
Other - please list:					

13) Compared to training in previous seasons, do you think this year's PAFIX Warm-Up Program was:

	Yes	No	Same	Don't Know
Of more benefit to team performance	☐	☐	☐	☐
Of more benefit to player performance	☐	☐	☐	☐
More relevant to the game	☐	☐	☐	☐
Harder	☐	☐	☐	☐
More enjoyable	☐	☐	☐	☐
More of a physical challenge for players	☐	☐	☐	☐
Better at preventing injury	☐	☐	☐	☐
Boring for players	☐	☐	☐	☐
Not challenging enough	☐	☐	☐	☐
Too time consuming	☐	☐	☐	☐
Too much effort	☐	☐	☐	☐
Less suitable	☐	☐	☐	☐
Other - please list:				

14) Overall, how would you rate the "PAFIX Warm Up Program" for your players?

☐ High intensity ☐ Moderate intensity ☐ Low intensity

15) Were the PAFIX training Warm Up sessions:

☐ Too long ☐ Too short ☐ Just right ☐ Don't know

16) Was the variety of exercises in the "PAFIX Warm Up Program":

☐ Good ☐ Adequate ☐ Poor ☐ Don't know

17) Was the timing of changes to the "PAFIX Warm Up Program" (e.g. every 3-5 weeks):

☐ Too long ☐ Too short ☐ Just right ☐ Don't know

18) Over the 2008 football season, did you see improvements in the following fitness parameters in your players participating in the PAFIX Warm-Up Program *(please circle your response)*

Strength	Fitness	Endurance	Agility	Balance	Speed
Yes	Yes	Yes	Yes	Yes	Yes
No	No	No	No	No	No
Don't Know	Don't Know	Don't Know	Don't Know	Don't Know	Don't Know

19. If you had a formal training plan for the season, did the PAFIX Warm-Up Program integrate well with your season plan?

☐ Yes ☐ No ☐ Not applicable

20. If you had a formal training plan for each session, did the PAFIX Warm-Up Program integrate well with your session plans?

☐ Yes ☐ No ☐ Not applicable

21. With the integration of the PAFIX program do you think you will modify or change the common training principles that you normally use?

☐ Yes ☐ No

22. Do you think you will utilise training methods employed in the PAFIX Warm-Up Program in season 2009?

☐ Yes ☐ No

If yes, out of all the program components, what training skills would you intend to use in the future? (List skills within program.)

____

____

23. How useful did you find the PAFIX results (e.g. fitness test results) provided to players:

☐ Very useful ☐ Somewhat useful ☐ Undecided ☐ Not very useful ☐ Not useful

24) From your perspective did the PAFIX trainer:

	Always	Often	Sometimes	Rarely	Never
a) provide interactive sessions?	☐	☐	☐	☐	☐
b) provide encouraging feedback to players?	☐	☐	☐	☐	☐
c) show enthusiasm and energy?	☐	☐	☐	☐	☐
d) demonstrate knowledge of training drills?	☐	☐	☐	☐	☐
e) show concern for player safety?	☐	☐	☐	☐	☐
f) keep the coaching team well informed?	☐	☐	☐	☐	☐

25) Did you observe the implementation of the PAFIX Warm-Up Program at each training session?

☐ Always ☐ Often ☐ Sometimes ☐ Rarely ☐ Never

26) Did you participate in the PAFIX Warm-Up Program with your players?

☐ Always ☐ Often ☐ Sometimes ☐ Rarely ☐ Never

27) Did you encourage players to participate in the PAFIX Warm-Up Program?

☐ Always ☐ Often ☐ Sometimes ☐ Rarely ☐ Never

Why?

28) Did you feel that it was important to encourage players to participate in the PAFIX Warm-Up Program?

☐ Strongly disagree ☐ Disagree ☐ Neither agree or disagree ☐ Agree ☐ Strongly agree

Why?

29) Please rate the top 3 people who you believe were the most influential in your team participating in the PAFIX Warm-Up Program. 1=most influential; 3=least influential

☐ Coach ☐ PAFIX Trainer ☐ Physiotherapist ☐ Family ☐ Researcher

☐ President ☐ Other players ☐ Other coach ☐ Club Committee ☐ Club Trainers

30) Please indicate whether you believe each of the following individuals/groups agrees or disagrees with you undertaking the training skills in the PAFIX Warm-Up Program.

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
1. I believe the President thinks it's in my best interests.	1	2	3	4	5
2. I believe other coaches think it's in our best interests.	1	2	3	4	5
3. I believe players think it's in our best interests.	1	2	3	4	5
4. I believe the physiotherapist thinks it's in our best interests.	1	2	3	4	5
5. I believe the team trainer thinks it's in our best interests.	1	2	3	4	5
6. I believe the club committee thinks it's in our best interests.	1	2	3	4	5
7. I believe the team captain thinks it's in our best interests.	1	2	3	4	5
8. I believe the league thinks it's in our best interests.	1	2	3	4	5

31) Please indicate your response to the following statements about what is important to you.

	Not at all Important				Extremely Important
1. Doing what other coaches do is important to me.	1	2	3	4	5
2. Doing what the team physiotherapist thinks is important to me.	1	2	3	4	5
3. Doing what the president thinks is important to me.	1	2	3	4	5
4. Doing what the players think is important to me.	1	2	3	4	5
5. Doing what other coaches think is important to me.	1	2	3	4	5
6. Doing what the team trainer thinks is important to me.	1	2	3	4	5
7. Doing what the club committee thinks is important to me.	1	2	3	4	5
8. Doing what the PAFIX trainer thinks is important to me.	1	2	3	4	5

32) Do you think the "PAFIX Warm-Up Program" could be improved in any way?

☐ Yes ☐ No ☐ Not applicable

If yes, how?

33) Please indicate whether you agree or disagree with the following statements about Australian football.
(Please circle the relevant number for each statement)

	Strongly Agree	Agree	Neither Agree nor Disagree	Disagree	Strongly Disagree
1. Being involved in the PAFIX program improved my knowledge of specialised lower limb training skills	1	2	3	4	5
2. The decision to be involved in the PAFIX program was beyond my control	1	2	3	4	5
3. Whether I include the PAFIX program in in training sessions next season is completely up to me	1	2	3	4	5
4. I intend to include the training skills in the PAFIX program in training sessions in the 2009 season	1	2	3	4	5
5. I intend to include a modified version of the training skills undertaken in the PAFIX program in training sessions in the 2009 season	1	2	3	4	5
6. I am confident that I have the knowledge and skills to implement the PAFIX program for my team	1	2	3	4	5
7. I believe that the football club is committed to injury prevention	1	2	3	4	5

34) For me to include the PAFIX program in training sessions next season is:

Easy	1	2	3	4	5	Difficult

35) I am

Less likely	1	2	3	4	5	More likely

to implement the program in future seasons if I am provided training to enhance my skills and knowledge

36) If you had the opportunity would you agree to players and/or your club participating in similar training for football in the future?

☐ Yes ☐ No ☐ Don't know

Please explain why you answered the way you did.

37) Overall, I think the PAFIX training program is:

The wrong thing to do	1	2	3	4	5	The right thing to do
Good practice	1	2	3	4	5	Bad practice

38) Is there anything else you would like to tell us about the PAFIX Warm-Up Program? (i.e. advantages/disadvantages)

____

____

____

Thank you for your participation in the completion of the survey and your involvement in the PAFIX Warm-Up Program with your club.

PAFIX PREVENTING AUSTRALIAN FOOTBALL INJURIES THROUGH EXERCISE

THE UNIVERSITY OF WESTERN AUSTRALIA

Appendix H: Data Collection and Management Forms

PDC Name: Club/Team: Date:

Guidelines for Administration of PAFIX Post Season Player/Coach Survey '07

To ensure consistency in administration of the PAFIX post season player/coach survey with each football club these guidelines have been developed to assist you. ***Please tick each box below as you complete recommended guidelines.*** *Please provide survey administration feedback on the following page as per guideline 13.*

Prior to administration of surveys

☐ 1. Prepare spreadsheet or list of *players* (names and identification number) as per *team*, for each *football club* prior to survey administration that you are involved with (if you do not have this already). Please include **date of survey administration** on the spreadsheet or list that you prepare. This will ensure players names can be checked on the list as they complete surveys and identify players we may need to follow up if they were not at training etc.

☐ 2. Please collect the number of surveys required as per your club/team and ensure you have the correct amount.

☐ 3. Print approximately 5-10 copies of the informed consent to provide to players in the instance where they did not complete pre season.

☐ 4. Please ensure a suitable area is set up where players can undertake surveys.

Administration

☐ 4. Thank players for participating in the "PAFIX Warm-Up Program" conducted by the University and request that the Post Season Survey be completed. Advice players that the survey is similar to the pre season survey they may have undertaken and the purpose of the survey is to get feedback about "PAFIX Warm-Up Program" that they undertook during football season 2007.

☐ 5. Please provide surveys and pens to players to complete survey.

☐ 6. Advice players that the information collected will remain **strictly confidential** and will not be released by the research investigators unless required so by law.

☐ 7. Advice players that the survey may take up to 15-20 minutes to complete and to return the survey back to you ("PDC") when completed, which will then be placed in an envelope or box.

☐ 8. Please advice players/coaches to complete all questions.

☐ 9. Also let players know that you may be able to assist them if they have any queries or difficulties with questions.

☐ 10. If there are instances where a player may have literacy problems, please use your discretion and ensure the player is assisted in an appropriate manner.

☐ 11. When the survey is provided back to you, please **write the "date" completed in the top right hand corner of the survey**. If you have the player/s identification number available please also record this in the same box. Please tick name on your player list.

☐ 12. If in the instance players did not complete a participant consent form pre season, please provide to applicable players.

☐ 13. Please note any difficulties with survey administration or delivery with club/players (ie. survey guidelines, set up with club, preparation, administration, data collection etc.) that you may have encountered and any recommendations or suggestions for future survey administration with club/players. Please also provide any observations that may be relevant. {feedback form attached}

☐ 14. <u>Please provide all surveys, player/coach lists, administration guideline sheet, and survey administration feedback form to</u>: James Dunne or Tim Doyle,
School of Human Movement & Exercise Sciences
University of Western Australia

☐ 15. <u>All player/coach surveys, player/coach lists, administration guideline sheets, and survey administration feedback forms to be sent to</u>: Angela McGlashan
School of Human Movement & Sports Sciences
University of Ballarat
Mt Helen Campus, PO Box 663, Mt Helen, Victoria 3353

PDC Name: Club/Team: Date:

Survey Administration Feedback Form

Please outline brief process and detail any difficulties throughout the survey administration process that you encountered and any recommendations or suggestions for future survey administration with club/players. This may also include your observations whilst administering surveys or any feedback that you received from club/players. Thankyou for your feedback.

PDC Name: Club/Team: Date:

Guidelines for Administration of PAFIX Post Season Coach/Player Survey '08

To ensure consistency in administration of the PAFIX Post Season 2008 coach/player surveys with each football club these guidelines have been developed to assist you. ***Please tick each box below as you complete recommended guidelines.*** *Please provide survey administration feedback on the following page as per guideline 13.*

Prior to administration of surveys

☐ 1. Prepare spreadsheet or list of *players/coaches* (names and identification number) as per *team*, for each *football club* prior to survey administration that you are involved with (if you do not have this already). Please include **date of survey administration** on the spreadsheet or list that you prepare. This will ensure players names can be checked on the list as they complete surveys and identify players we may need to follow up if they were not at training etc.

☐ 2. Please collect the number of surveys required as per your club/team and ensure you have the correct amount.

☐ 3. Print approximately 5-10 copies of the informed consent to provide to players in the instance where they did not complete pre season or during the season.

☐ 4. Please ensure a suitable area is set up where players/coaches can complete surveys.

Administration

☐ 4. Thank coaches/players for participating in the "PAFIX Warm-Up Program" conducted by the University and request that the Post Season Survey be completed. Advice players/coaches that the survey is similar to the pre season survey (that they may have undertaken) and the purpose of the survey is to get feedback about "PAFIX Warm-Up Program" that they undertook during football season 2008.

☐ 5. Please provide surveys and pens to players to complete survey.

☐ 6. Advice players that the information collected will remain **strictly confidential** and will not be released by the research investigators unless required so by law.

☐ 7. Advice players that the survey may take up to 15-20 minutes to complete and to return the survey back to you ("PDC") when completed, which will then be placed in an envelope or box.

☐ 8. Please advice players to complete all questions (honestly, as possible)

☐ 9. Also let players know that you may be able to assist them if they have any queries or difficulties with questions.

☐ 10. If there are instances where a player may have literacy problems, please use your discretion and ensure the player is assisted in an appropriate manner.

☐ 11. When the survey is provided back to you, please **write the "date" completed in the top right hand corner of the survey**. If you have the player/s identification number available please also record this in the same box. Please tick name on your player list.

☐ 12. If in the instance players did not complete a participant consent form pre season, please provide to applicable players.

☐ 13. Please note any difficulties with survey administration or delivery with club/players (ie. survey guidelines, set up with club, preparation, administration, data collection etc.) that you may have encountered and any recommendations or suggestions for future survey administration with club/players. Please also provide any observations that may be relevant. {feedback form attached}

☐ 14. <u>Please provide all surveys, player lists, administration guideline sheet, and survey administration feedback form to</u>: Tim Doyle,
School of Human Movement & Exercise Sciences
University of Western Australia

☐ 15. <u>All player surveys, player lists, administration guideline sheets, and survey administration feedback forms to be sent to</u>: Angela McGlashan
School of Human Movement & Sports Sciences
University of Ballarat
Mt Helen Campus, PO Box 663, Mt Helen, Victoria 3353

PDC Name: Club/Team: Date:

Survey Administration Feedback Form

Please outline brief process and detail any difficulties throughout the survey administration process that you encountered and any recommendations or suggestions for future survey administration with club/players. This may also include your observations whilst administering surveys or any feedback that you received from club/players. Thankyou for your feedback.

PDC Name: Club/Team: Date:

Guidelines for Administration of PAFIX Pre Season Player/Coach Survey

To ensure consistency in administration of the PAFIX pre season player/coach surveys with each football club these guidelines have been developed to assist you. ***Please tick each box below as you complete recommended guidelines.*** *Please provide survey administration feedback on the following page as per guideline 13.*

<u>Prior to administration of surveys</u>

☐ 1. Prepare spreadsheet or list of *players/coaches* (names and identification number) as per *team*, for each *football club* prior to survey administration that you are involved with (if you do not have this already). Please include **date of survey administration** on the spreadsheet or list that you prepare. This will ensure players names can be checked on the list as they complete surveys and identify players we may need to follow up if they were not at training etc. (If this is not possible prior to survey administration please compile list as you administer surveys and request full list of players).

☐ 2. Please collect the number of surveys required as per your club/team and ensure you have the correct amount.

☐ 3. Ensure you have substantial copies of the informed consent to provide to players in the instance where they did not complete prior to completing the survey.

☐ 4. Please ensure a suitable area is set up where players/coaches can complete surveys.

<u>Administration</u>

☐ 4. Thank players/coaches for participating in the "PAFIX Warm-Up Program" conducted by the University and request that the Pre Season Survey be completed. Brief them on the PAFIX project if not already done so.

☐ 5. Please provide surveys and pens to players/coaches to complete survey.

☐ 6. Advise players/coaches that the information collected will remain **strictly confidential** and will not be released by the research investigators unless required so by law.

☐ 7. Advise players/coaches that the survey may take up to 10-15 minutes to complete and to return the survey back to you ("PDC") when completed, which will then be placed in an envelope or box.

☐ 8. Please advise players/coaches to complete all questions and as honestly as possible

☐ 9. Also let players know that you may be able to assist them if they have any queries or difficulties with questions.

☐ 10. If there are instances where a player may have literacy problems, please use your discretion and ensure the player is assisted in an appropriate manner.

☐ 11. When the survey is provided back to you, please **write the "date" completed in the top right hand corner of the survey**. If you have the player/s identification number available please also record this in the same box. Please tick name on your player list.

☐ 12. If in the instance players did not complete a participant consent form, please provide to applicable players.

☐ 13. Please note any difficulties with survey administration or delivery with club/players (ie. survey guidelines, set up with club, communication, preparation, administration, data collection etc.) that you may have encountered and any recommendations or suggestions for future survey administration with club/players. Please also provide any observations that may be relevant. {feedback form attached}

☐ 14. <u>Please provide all surveys, player lists, administration guideline sheet, and survey administration feedback form to</u>: Tim Doyle,
School of Human Movement & Exercise Sciences
University of Western Australia

☐ 15. <u>All player surveys, player lists, administration guideline sheets, and survey administration feedback forms to be sent to</u>: Angela McGlashan
School of Human Movement & Sports Sciences
University of Ballarat
Mt Helen Campus, PO Box 663, Mt Helen, Victoria 3353

PDC Name: Club/Team: Date:

Survey Administration Feedback Form

Please outline brief process and detail any difficulties (or things that went well) throughout the survey administration process that you encountered and any recommendations or suggestions for future survey administration with club/players. This may also include your observations whilst administering surveys or any feedback that you received from club/players. Thankyou for your feedback.

PREVENTING AUSTRALIAN FOOTBALL INJURIES THROUGH EXERCISE

THE UNIVERSITY OF WESTERN AUSTRALIA

PARTICIPATION INFORMATION STATEMENT

BACKGROUND AND PURPOSE

Australian football is one of the most popular team sports in Australia. Given the high levels of participation, it is not surprising that football ranks as one of the sports with a high number of presentations for injury treatment. The intense competition and physical demands of football contribute to the high risk of injury. While injury preventive measures have been adopted to varying degrees, there is currently a lack of evidence for the effectiveness of these interventions in preventing injuries to footballers.

One common recommended strategy to reduce the number of injuries in football is a well-designed exercise training program. However, despite the potential of exercise programs to prevent football injuries, the value of different types of programs has not been determined. There is a particular need for the development of exercise training programs for community level players as a majority of participants in the sport play at this level. This study will determine whether different training programs can prevent injuries in community level adult football players by monitoring injury rates throughout the 2007/08 seasons, and player behaviour and attitudes before and after the programs are implemented.

This study is being conducted in the two leading Australian football states of Victoria and Western Australia. We are investigating if specially designed training programs will reduce the number of lower limb injuries that occur in football players. It is important to discover ways to reduce the risk of lower limb injury in this sport because of how common they are, how serious they are and the likelihood of long-term detrimental effects, such as the high risk of developing knee osteoarthritis.

We have developed some specially designed exercise training programs, which have shown promise in reducing the physical loads experienced by the lower limb during sporting tasks that cause injury. We now need to find out if these changes lead to reduced injury rates and improved performance in football.

INVITATION

You are invited to participate in this important study of exercise training programs for preventing injuries in football players. In this study, we will ask you to participate in either an experimental or control training program as part of your normal team training. Your team will have a 50% chance of being assigned to either the experimental or control training program, but we will not tell you to which group you have been assigned. Either program should be of benefit to your team's training.

You were selected as a possible participant in this study because you are 18 years or older and play football in a community level competition.

It is hoped that the findings of this study will determine which exercise training programs best prevent injuries in footballers.

Of course, the results of the study will be provided to all participants.

PROCEDURES

We hope to demonstrate that special training changes the way football players perform particular football movements, and that these changes are related to reduce injury rates. We will learn about how football-specific exercise training programs can prevent injuries in community level players by monitoring injury rates throughout the 2007/08 playing seasons. We will also assess players' training habits and attitudes towards exercise training programs and injury risk both before and after you undertake the exercise training programs.

Your team, having volunteered to take place in the study will be assigned a trainer, who will instruct you in the training program that your team has been allocated. Your team trainer will have full instructions of all the training drills, which you will be required to perform every time your team has a scheduled training. These will only take approximately 20 minutes and are appropriate to football, irrespective of what training group you are assigned to.

You will not need to do any more training than what you have been used to in the past. None of the exercises will involve physical movements that you would not otherwise undertake during a game of football.

The team trainer will record your attendance and level of participation in training every week, your game attendances, and any injuries that you sustain throughout the season.

At the start of the season we will also ask you to complete a survey. This will take about 10 minutes to complete and will ask you questions about your age, playing history, injury history, current training habits and attitudes towards training programs and risk of injury. We will also ask you to repeat this survey at the end of the season. As we will need to monitor the injuries that you receive across the season, and your participation habits, we will need to record your name on these surveys.

RISKS

Importantly, the exercises have been designed so that they will not cause injury. However, you may experience some minor discomfort or muscle soreness after the start of this exercise training if you are not used to physical activity. This delayed onset muscle soreness is normal and not an injury but to help prevent or minimise this, both stretching and warm-up exercises will be given to you for the next morning. The soreness should ease by a couple of days after the initial training.

CONFIDENTIALITY

All information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission, except as required by law.

You will be videoed performing the training for instructional purposes. For the duration of the study will have to be able to associate you with your videos. After study has been completed the videos may still need to be used but they will be de-identified. In the database, you will only be identified by a unique code number so that you will remain anonymous.

If you give us your permission by signing the player consent form, we plan to publish the results in medical and/or biomechanical scientific journals and at sports medicine and biomechanical conferences. A copy of each publication will be provided to each football club that participates in the study. In any publication, information will be provided in such a way that you cannot be identified. Only the combined results of all participants will be published.

Only the authorised research team will have access to the coded data which will be stored for at least seven years as prescribed by University regulations. All videos, test data, questionnaires, surveillance forms etc will be stored in locked fire proof cabinet, and data collected and processed will be stored on computers that are password protected.

BENEFITS

Even though the experimental intervention program has not been shown to reduce injury rates, it is based on previous scientific studies that have suggested that this should be an outcome of training. The results from the study will be of great benefit to the general community and sports medicine from a financial and social perspective if optimal training is established as it may lead to a decrease in the incidence of lower limb injuries. If the training program is successful in reducing lower limb injuries it will be made available to the control teams at the completion of the study. There may also be benefits to your team in terms of improved performance.

PARTICIPANT RIGHTS

If you have any questions concerning the research, please ask one of the researchers at any time.

Participation in this research is voluntary and you are free to withdraw from the study at any time and for any reason, without prejudice in any way. You do not have to give any justification for your decision and your records will be destroyed unless otherwise agreed by you. If you withdraw from the study you can do so without penalty or prejudice from your football club or the University of Ballarat or the University of Western Australia by returning a completed revocation of consent form.

Your participation in this study does not prejudice any right to compensation, which you may have under the statute of common law.

For Victorian Players: Complaints may be directed to the Executive Officer, Human Research Ethics Committee, Research & Graduates Studies Office, University of Ballarat, PO Box 663, Mt Helen, VIC 3353. Telephone: (03) 5327 9765. Any complaints will be treated in confidence and investigated, and you will be informed of the outcome.

FURTHER INFORMATION

If you have any questions, please feel free to ask us. If you have any additional questions later, a member of the research team will be happy to answer them. This study is being conducted by a collaborative group of researchers. The research team comprises of Professor Caroline Finch and Dr. Dara Twomey from the University of Ballarat, and Dr David Lloyd, Professor Bruce Elliot and Dr. Tim Doyle from the University of Western Australia.

For Victorian players, further information about this study can be obtained from Professor Caroline Finch or Dr. Dara Twomey on (03) 5327 9062 or d.twomey@ballarat.edu.au.

PREVENTING AUSTRALIAN FOOTBALL INJURIES THROUGH EXERCISE

THE UNIVERSITY OF WESTERN AUSTRALIA

PARTICIPATION INFORMATION STATEMENT

BACKGROUND AND PURPOSE

Australian football is one of the most popular team sports in Australia. Given the high levels of participation, it is not surprising that football ranks as one of the sports with a high number of presentations for injury treatment. The intense competition and physical demands of football contribute to the high risk of injury. While injury preventive measures have been adopted to varying degrees, there is currently a lack of evidence for the effectiveness of these interventions in preventing injuries to footballers.

One common recommended strategy to reduce the number of injuries in football is a well-designed exercise training program. However, despite the potential of exercise programs to prevent football injuries, the value of different types of programs has not been determined. There is a particular need for the development of exercise training programs for community level players as a majority of participants in the sport play at this level. This study will determine whether different training programs can prevent injuries in community level adult football players by monitoring injury rates throughout the 2007/08 seasons, and player behaviour and attitudes before and after the programs are implemented.

This study is being conducted in the two leading Australian football states of Victoria and Western Australia. We are investigating if specially designed training programs will reduce the number of lower limb injuries that occur in football players. It is important to discover ways to reduce the risk of lower limb injury in this sport because of how common they are, how serious they are and the likelihood of long-term detrimental effects, such as the high risk of developing knee osteoarthritis.

We have developed some specially designed exercise training programs, which have shown promise in reducing the physical loads experienced by the lower limb during sporting tasks that cause injury. We now need to find out if these changes lead to reduced injury rates and improved performance in football.

INVITATION

You are invited to participate in this important study of exercise training programs for preventing injuries in football players. In this study, we will ask you to participate in either an experimental or control training program as part of your normal team training. Your team will have a 50% chance of being assigned to either the experimental or control training program, but we will not tell you to which group you have been assigned. Either program should be of benefit to your team's training.

You were selected as a possible participant in this study because you are 18 years or older and play football in a community level competition.

It is hoped that the findings of this study will determine which exercise training programs best prevent injuries in footballers.

Of course, the results of the study will be provided to all participants.

PROCEDURES

We hope to demonstrate that special training changes the way football players perform particular football movements, and that these changes are related to reduce injury rates. We will learn about how football-specific exercise training programs can prevent injuries in community level players by monitoring injury rates throughout the 2007/08 playing seasons. We will also assess players' training habits and attitudes towards exercise training programs and injury risk both before and after you undertake the exercise training programs.

Your team, having volunteered to take place in the study will be assigned a trainer, who will instruct you in the training program that your team has been allocated. Your team trainer will have full instructions of all the training drills, which you will be required to perform every time your team has a scheduled training. These will only take approximately 20 minutes and are appropriate to football, irrespective of what training group you are assigned to.

You will not need to do any more training than what you have been used to in the past. None of the exercises will involve physical movements that you would not otherwise undertake during a game of football.

The team trainer will record your attendance and level of participation in training every week, your game attendances, and any injuries that you sustain throughout the season.

At the start of the season we will also ask you to complete a survey. This will take about 10 minutes to complete and will ask you questions about your age, playing history, injury history, current training habits and attitudes towards training programs and risk of injury. We will also ask you to repeat this survey at the end of the season. As we will need to monitor the injuries that you receive across the season, and your participation habits, we will need to record your name on these surveys.

Ten people will be randomly selected from each of the Western-Australian based teams to be involved in a set of **biomechanical** and **neuromuscular tests**. If selected, you will be asked to attend two testing sessions in School of Human Movement and Exercise Science Sports Motion Analysis Laboratory at the University of Western Australia. The first test session will be in the pre-season prior to training and the second session about 12 weeks into the season. Both testing sessions will be about 2hrs long and you will be financially compensated for inconvenience, time spent and travel costs incurred in attending the tests.

In the **biomechanical tests** the externally applied loading to knee joint and muscle activation patterns will be collected, while you perform different sporting manoeuvres. These tasks to be tested are landing, sidestepping, crossover cutting and running. Your movements will be recorded by the Oxford Metrics Vicon three-dimensional motion analysis system. At the same time a force plate in walkway surface will measure the forces you exert on the ground. Your muscle activation patterns, or electromyographic (EMG) data, are also collected. You will be asked to perform the manoeuvres at a speed equivalent to a medium jog (12-15km/hr), which is a safe speed and should not be of concern from an injury or training level perspective.

To enable us to measure your movement, lightweight retro-reflective markers are stuck on your skin with double-sided tape. The motion analysis system only records the movement of these markers direct to the computer, as well as takes video images of you performing the tasks. The measurement of your muscle activation patterns requires us to place disposal electrodes on the skin over your leg muscles.

In the **neuromuscular tests** you will have your a) knee movement sense and position sense assessed; b) knee strength; and c) standing balance. Finally, your mobility in game situation will be assessed by a) agility cone test and b) reaction time to perform the cutting manoeuvres in response to a light stimulus.

A qualified instructor will supervise all testing sessions and demonstrate the required tasks.

RISKS

The sidestepping manoeuvres performed in training and in biomechanics tests are commonly related to injury in sport. However, the speed at which you will be asked to perform these manoeuvres at is a medium jog (12-15km/hr), which should place you at very little risk at all to injury. We have used these similar protocols on over 100 people in past 4 years and no injuries have occurred.

Importantly, the exercises have been designed so that they will not cause injury. However, you may experience some minor discomfort or muscle soreness after the start of this exercise training if you are not used to physical activity. This delayed onset muscle soreness is normal and not an injury but to help prevent or minimise this, both stretching and warm-up exercises will be given to you for the next morning. The soreness should ease by a couple of days after the initial training.

For the EMG to work, the electrodes need to have a clean contact with the skin. This requires us to shave and clean the area onto which the electrode will be placed. This process, along with the electrode gel applied to gain greater conductivity, can cause some minor irritation that should abate quickly. In addition, the markers placed on your body to measure movement are stuck to your skin with low allergenic tape. This may also cause some minor skin irritation that should abate quickly.
Since you may be unaccustomed to exercises in training and in the biomechanical tests, you may feel some minor discomfort from these sessions (delayed onset muscle soreness) but stretching and warm up included before the testing will help to alleviate this. There is no long-term discomfort caused by participation in this study.

CONFIDENTIALITY

All information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission, except as required by law.

You will be videoed performing the training for instructional purposes. You will be also videoed during the biomechanical testing to ensure that side steps you perform are valid and error free. For the duration of the study will have to be able to associate you with your videos. After study has been completed the videos may still need to be used but they will be de-identified. In the database, you will only be identified by a unique code number so that you will remain anonymous.

If you give us your permission by signing the player consent form, we plan to publish the results in medical and/or biomechanical scientific journals and at sports medicine and biomechanical conferences. A copy of each publication will be provided to each football club that participates in the study. In any publication, information will be provided in such a way that you cannot be identified. Only the combined results of all participants will be published.

Only the authorised research team will have access to the coded data which will be stored for at least seven years as prescribed by University regulations. All videos, test data, questionnaires, surveillance forms etc will be stored in locked fire proof cabinet, and data collected and processed will be stored on computers that are password protected.

BENEFITS

Even though the experimental intervention program has not been shown to reduce injury rates, it is based on previous scientific studies that have suggested that this should be an outcome of training. The results from the study will be of great benefit to the general community and sports medicine from a financial and social perspective if optimal training is established as it may lead to a decrease in the incidence of lower limb injuries. If the training program is successful in reducing lower limb injuries it will be made available to the control teams at the completion of the study. There may also be benefits to your team in terms of improved performance.

PARTICIPANT RIGHTS

If you have any questions concerning the research, please ask one of the researchers at any time.

Participation in this research is voluntary and you are free to withdraw from the study at any time and for any reason, without prejudice in any way. You do not have to give any justification for your decision and your records will be destroyed unless otherwise agreed by you. If you withdraw from the study you can do so without penalty or prejudice from your football club or the University of Ballarat or the University of Western Australia by returning a completed revocation of consent form.

Your participation in this study does not prejudice any right to compensation, which you may have under the statute of common law.

For Western Australian Players: The Human Research Ethics Committee at the University of Western Australia requires that all participants are informed that, if they have any complaint regarding the manner, in which a research project is conducted, it may be given to the researcher or, alternatively to the Secretary, Human Research Ethics Committee, Registrar's Office, University of Western Australia, 35 Stirling Highway, Crawley, WA 6009 (telephone number 6488-3703). All study participants will be provided with a copy of the Information Sheet and Consent Form for their personal records. Any complaints will be treated in confidence and investigated, and you will be informed of the outcome.

FURTHER INFORMATION

Further information regarding this study may be obtained Dr David Lloyd or Professor Bruce Elliott on 6488 2361.

If you have any questions, please feel free to ask us. If you have any additional questions later, a member of the research team will be happy to answer them. This study is being conducted by a collaborative group of researchers. The research team comprises of Professor Caroline Finch and Dr. Dara Twomey from the University of Ballarat, and Dr David Lloyd, Professor Bruce Elliot and Dr. Tim Doyle from the University of Western Australia.

For Western Australian players, further information about this study can be obtained Dr David Lloyd or Professor Bruce Elliott or Dr Tim Doyle on 6488 2361.

PREVENTING AUSTRALIAN FOOTBALL INJURIES THROUGH EXERCISE

THE UNIVERSITY OF WESTERN AUSTRALIA

PARTICIPANT CONSENT FORM

I (the participant) have read and understand the PAFIX Project Information Statement, and any questions I have asked have been answered to my satisfaction. I agree to participate in the activity, realising that I am free to withdraw from the study at any point in time, and that I do not have to provide a reason for doing so. I understand that, if I do choose to withdraw from the study, there will be no penalty whatsoever to myself or to any other players in my team.

I understand that all information provided is treated as strictly confidential and will not be released by the investigators unless required to so by law. I have been also advised as to what data is being collected, what the purpose is, and what will be done with the data upon completion of the research.

I agree that research data gathered for the study may be published provided that my name or other identifying information is not used.

.... *Signature of Research Participant*

.... *Signature of Witness*

.... *(Please PRINT name)*

.... *(Please PRINT name)*

/ /
.... *Date*

.... *Nature of Witness*

.... *Contact Phone Number*

For Western Australian Participants
The Human Research Ethics Committee at the University of Western Australia requires that all participants are informed that, if they have any complaint regarding the manner, in which a research project is conducted, it may be given to the researcher or, alternatively to the Secretary, Human Research Ethics Committee, Registrar's Office, University of Western Australia, 35 Stirling Highway, Crawley, WA 6009 (telephone number 6488-3703). All study participants will be provided with a copy of the Information Sheet and Consent Form for their personal records.

For Victorian Participants
Complaints may be directed to the Executive Officer, Human Research Ethics Committee, Research & Graduates Studies Office, University of Ballarat, PO Box 663, Mt Helen, VIC 3353. Telephone: (03) 5327 9765. Any complaints will be treated in confidence and investigated, and you will be informed of the outcome.

FOR OFFICE USE ONLY: Signature of Investigator DATE...............................

UNIVERSITY OF BALLARAT

SCHOOL OF HUMAN MOVEMENT & SPORT SCIENCES

PLAIN LANGUAGE INFORMATION STATEMENT - INTERVIEWS

PROJECT TITLE:	**Factors influencing the uptake and maintenance of exercise training programs for preventing lower limb injuries**
PRINCIPAL RESEARCHER:	**Professor Caroline Finch (03) 5327 9878**
OTHER/STUDENT RESEARCHERS:	**Ms Angela McGlashan (03) 5327 9877** **Professor Sally Wellard (03) 5327 9663** **Dr Dara Twomey (03) 5327 9062**

BACKGROUND AND PURPOSE

Australian football is one of the most popular team sports in Australia. Given the high levels of participation, it is not surprising that football ranks as one of the sports with a high number of presentations for injury treatment. The intense competition and physical demands of football contribute to the high risk of injury. While injury prevention measures have been adopted to varying degrees, there is currently a lack of evidence for the effectiveness of these interventions in preventing injuries to footballers. Research and evaluation of effective injury prevention measures is therefore required, as is understanding of how we can best deliver injury prevention measures in community clubs.

One common recommended strategy to reduce the number of injuries in football is a well-designed exercise training program. However, despite the potential of exercise training programs to prevent football injuries, the value of different types of programs has not been determined. There is a particular need for the development of exercise training programs for community level players as a majority of participants in the sport play at this level. It is important to discover ways to reduce the risk of lower limb injury in this sport because of how common they are, how serious they are and the likelihood of long-term detrimental effects, such as the high risk of developing knee osteoarthritis.

As you are aware, the University of Ballarat in conjunction with the University of Western Australia conducted a major study initiative in the two leading Australian football states of Victoria and Western Australia. The project is known as Preventing Australian Football Injuries through Exercise (PAFIX). This study investigated if specifically designed training programs could reduce the number of lower limb injuries that occur in football players. Monitoring of injury rates and playing/training habits throughout the 2007/08 seasons was undertaken and a survey of player and coach behaviours and attitudes completed at the end and start of each season.

As a follow-up to the larger PAFIX trial, we want to find out what things determine and influence players undertaking these sorts of exercises and making them part of their training regimens for the long-term. We will be seeking this information from players, coaches and other representatives of the Australian football clubs who participated in the PAFIX trial.

INVITATION

You are invited to be part of this important study as a follow-up to the PAFIX trial. This phase of research will involve face-to-face interviews with players, coaches and presidents involved in the PAFIX trial. This will take about 60-90 minutes and will be arranged at a mutually agreed time and place. The interview will be audio-taped so that we can later type up a record of what was said. You will be asked questions about your club, current training patterns, and factors that make a difference to you using the PAFIX program as part of your long-term training program. You are free to choose not to answer questions during the interview. A summary of the interview will be given to you for comment, as well as any proposed changes for future introduction of such programs.

We hope the findings of this study will give a new understanding of factors associated with uptake and maintenance of lower limb injury prevention strategies and provide new information about how to best work with Australian football clubs, administrators, coaches and players to make the best use of injury interventions to prevent lower limb injuries in the future. We hope this will also support the promotion of long-term safe participation in football.

If you feel upset in any way during the group discussions, you can stop participating and if you want assistance, a qualified psychologist/counsellor, will be available for consultation. Alternatively, you may also wish to contact Lifeline (24-hour telephone counselling service) on 131114.

An informed consent statement is attached for your information. Please read this statement as we need to your signed consent for you to participate in the study.

CONFIDENTIALITY

All information that is obtained in connection with this study and that can be identified with you will remain confidential and will be disclosed only with your permission, except as required by law.

If you give us permission by signing the consent form, results will be used for research purposes and may be reported in scientific journals and at sports medicine and injury prevention conferences. A copy of each publication will be provided to your football club. In any publication, information will be provided in such a way that you cannot personally be identified. The information obtained will also be shared with other Australian football clubs/bodies and the broader community so that community football can be made as safe as possible across the country.

Only the authorised research team will have access to the coded data which will be stored for at least seven years as prescribed by the University regulations. All audio-tapes and transcriptions will be stored securely and destroyed after 7 years.

BENEFITS

From a public health perspective, community Australian football is a very popular sport. The results of this study will be of great benefit to community football because if optimal training programs can be established and maintained over time many lower limb injuries could be prevented from occurring and enable players to play the game for longer. The information obtained from your participation in this study will assist us in establishing how to best work with Australian football bodies and administrators, coaches and players to maximise the uptake of injury interventions to prevent lower limb injury in the future.

PARTICIPANTS RIGHTS

If you have any questions, or would like further information concerning the research, please ask one of the researchers at anytime.

Participation in this research is voluntary and you are free to withdraw at anytime and for any reason (up until your data is de-identified and aggregated) and for any reason, without prejudice in any way. You do not have to give justification for your decision and your records will be destroyed unless otherwise agreed by you. If you withdraw from the study you can do so *without* penalty or prejudice from your football club or the University of Ballarat by returning a completed withdrawal of consent form.

Your participation in this study does not prejudice any right to compensation, which you may have under the statute of common law.

Complaints may be directed to the Executive Officer, Human Research Ethics Committee, Research and Graduate Studies Office, University of Ballarat, PO Box 663, Mt Helen, VIC 3353. Telephone: (03) 5327 9765. Any complaints will be treated in confidence and investigated, and you will be informed of the outcome.

If you have any questions, or you would like further information regarding the project titled **Factors influencing the uptake and maintenance of exercise training programs for preventing lower limb injuries**, please contact the Principal Researcher, **Professor Caroline Finch** of the School of **Human Movement and Sport Sciences**:

PH: (03) 5327 9878

EMAIL: c.finch@ballarat.edu.au

Or

Research Coordinator, Ms Angela McGlashan

PH: 5327 9877

EMAIL: a.mcglashan@ballarat.edu.au

Should you (i.e. the participant) have any concerns about the **ethical** conduct of this research project, please contact the University of Ballarat Ethics Officer, Research & Graduates Studies Office, University of Ballarat, PO Box 663, Mt Helen VIC 3353. Telephone: (03) 5327 9765, Email: ub.ethics@ballarat.edu.au

CRICOS Provider Number 00103D

PARTICIPANT INFORMED CONSENT

PROJECT TITLE:	Factors influencing the uptake and maintenance of exercise training program preventing lower limb injuries
RESEARCHERS:	**Ms Angela McGlashan** **Professor Caroline Finch** **Professor Sally Wellard** **Dr Dara Twomey**

Code number allocated to the participant:	

<u>Consent – Please complete the following information:</u>

I, ... of . . . .

. . . .
hereby consent to participate as a subject in the above research study.

The research program in which I am being asked to participate has been explained fully to me, verbally and in writing, and any matters on which I have sought information have been answered to my satisfaction.

I understand that

- all information I provide will be treated with the strictest confidence and data will be stored separately from any listing that includes my name and address.
- the interview/focus group discussions will be audiotaped and later transcribed.
- aggregated results will be used for research purposes and may be reported in scientific and academic journals.
- I am free to decline to participate or withdraw my consent at any time during the study in which event my participation in the research study will immediately cease and any information obtained from it will not be used.
- once information has been aggregated it is unable to be identified, and from this point it is not possible to withdraw consent to participate.

SIGNATURE: . . . . **DATE**: . . . .

Contact Phone Number ....

Football Club..

PARTICIPANT WITHDRAWAL OF CONSENT FORM

PROJECT TITLE:	Factors influencing the uptake and maintenance of exercise training programs for preventing lower limb injuries
RESEARCHERS:	**Ms Angela McGlashan** **Professor Caroline Finch** **Professor Sally Wellard** **Dr Dara Twomey**

I hereby wish to **WITHDRAW** my consent to participate in the research project described above and understand that such withdrawal **WILL NOT** jeopardise my relationship (if any) with the University of Ballarat or my football club.

…………………………………….
Signature of Research Participant

……………………………………..
(Please PRINT name)

……………………………………..
Football team

/ /
……………………………………..
Date

This withdrawal form should be forwarded to

Prof Caroline Finch
School of Human Movement and Sport Sciences
University of Ballarat
PO Box 663
Mt Helen Campus
Victoria 3353

or

Ms Angela McGlashan
School of Human Movement and Sport Sciences
University of Ballarat
PO Box 663
Mt Helen Campus
Victoria 3353

Appendix I: Postseason Survey CrossTab Summary

Coach Post Season (Cross Tabs-Pearson's Chi-Square)	Year	State	Club	Intervention Arm	DOB	Age	Coaching position	Highest coach qual	Yr obtained coach qual	Yrs since obtained coach qual	Yrs played AF	Highest level played AF	Yrs coached	Highest level coached AF	Player-coach for your club?
Intentions															
I would implement specific types of training in my sessions if they were shown to improve football performance in my players	.756	.394	.892	.486	.298	.714	.382	.677	.830	.519	.416	.023*	.070	.203	.308
I would implement specific types of training in my sessions if they were shown to prevent LLIs in my players	.288	.862	.196	.062	.411	.193	.588	.746	.246	.504	.067	.123	.004	.224	.914
I would implement specific types of training in my sessions if they were shown to improve football performance and prevent LLIs in my players	.657	.310	.710	.698	.324	.523	.108	.833	.830	.491	.575	.419	.229	.205	.512
Perceived Susceptibility															
Players are more at risk of LLIs now than 10 years ago	.534	.089	.475	.324	.370	.297	.086	.395	.236	.302	.317	.647	.430	.702	.343
Players are more at risk of LLIs when playing on hard/dry grounds	.127	.055*	.195	.916	.298	.393	.568	.300	.680	.549	.636	.507	.334	.350	.136
A player's chance of getting a lower limb injury whilst playing football is high	-	.083	.108	.591	.368	.421	.455	.425	.822	.787	.274	.363	.866	.468	.544
LLIs are not a problem for my team	.134	.271	.415	.615	.381	.258	.638	.292	.363	.417	.780	.709	.435	.025	.267
Perceived Severity															
Players with LLIs are usually not available to play for one or more weeks	.347	.702	.410	.108	.452	.367	.694	.130	.136	.103	.086	.188	.496	.261	.129
LLIs negatively influence game performance and end of season results for my team	.642	.373	.595	.808	.298	.329	.090	.750	.737	.480	.545	.176	.140	.118	.281
A serious lower limb injury could have a negative impact on a player's life	-	.166	.551	.715	.355	.368	.432	.004*	.084	.106	.704	.150	.519	.378	.443
A serious lower limb injury could stop a player from undertaking their day to day employment	-	.056*	.345	.669	.368	.220	.459	.011*	.343	.193	.894	.190	.897	.380	.235

Coach Post Season (Cross Tabs-Pearson's Chi-Square)	Year	State	Club	Intervention Arm	DOB	Age	Coaching position	Highest coach qual	Yr obtained coach qual	Yrs since obtained coach qual	Yrs played AF	Highest level played AF	Yrs coached	Highest level coached AF	Player-coach for your club?
Outcome expectations															
Incorporating lower limb prevention strategies is important when I plan my training sessions	.328	.918	.269	.323	.298	.375	.239	.195	.237	.335	.246	.399	.108	.830	.615
LLIs cannot be prevented	.368	.888	.382	.394	.298	.229	.348	.243	.493	.455	.679	.285	.106	.528	.804
It is important for players to attend training sessions if they want to remain injury free	.630	.411	.879	.508	.321	.283	.090	.708	.931	.691	.073	.121	.437	.345	.358
Improving team performance is important when planning my training sessions	.514	.478	.349	.450	.321	.689	.621	.259	.779	.747	.162	.308	.032	.187	.442
Preseason training is important for preventing LLIs in my players during the season	.552	.066	.570	.953	.408	.747	.100	.512	.818	.745	.392	.671	.020	.038	.232
It is important for players to attend training sessions if they want to play in games	.312	.213	.017*	.317	.361	.652	.611	.608	.606	.518	.384	.020*	.437	.345	.358
Self-efficacy															
I am the best source of information about how to prevent LLIs for my players	.158	.495	.039*	.607	.400	.492	.851	.462	.346	.440	.714	.990	.391	.021*	.410
Players are responsible for preventing their own LLIs	.298	.417	.585	.563	.275	.203	.093	.209	.245	.286	.136	.154	.068	.873	.517
It is important for me to have current knowledge of lower limb injury prevention strategies	.283	.906	.470	.226	.612	.277	.589	.638	.854	.788	.330	.923	.315	.666	.309

*shows significant difference between variables

Coach Post Season (Cross Tabs- Pearson's Chi-Square)	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**	**12**	**13**	**14**	**15**	**16**	**17**	**18**	**19**	**20**
1. Players are more at risk of LLIs now than 10 years ago		.172	.070	.672	.203	.010*	.057	.008*	.027*	.351	.003*	.439	.653	.052	.062	.586	.154	.277	.192	.248
2. Players are responsible for preventing their own LLIs	.172		.409	.110	.001*	.570	.113	.060	.372	.214	.140	.064	.744	.182	.125	.014	.687	.650	.353	.121
3. LLIs cannot be prevented	.070	.409		.536	.195	.252	.034*	.245	.147	.547	.015*	.465	.098	.293	.244	.581	.245	.452	.177	.501
4. LLIs are not a problem for my team	.672	.110	.536		.479	.460	.261	.770	.344	.766	.837	.172	.147	.122	.506	.007*	.411	.327	.286	.537
5. It is important for players to attend training sessions if they want to remain injury free	.203	.001*	.195	.479		.100	.104	.013	.169	.364	.081	.159	.816	.162	.230	.010*	.341	.287	.530	.492
6. I would implement specific types of training in my sessions if they were shown to improve football performance in my players	.010*	.570	.252	.460	.100		.000*	.000*	.000*	.001*	.001*	.177	.107	.313	.001*	.308	.000*	.238	.012*	.150
7. LLIs negatively influence game performance and end of season results for my team	.057	.113	.034*	.261	.104	.000*		.002*	.002*	.009*	.000*	.123	.223	.236	.001*	.326	.000*	.345	.023*	.350
8. Players with LLIs are usually not available to play for one or more weeks	.008*	.060	.245	.770	.013*	.000*	.002*		.000*	.005*	.002*	.002*	.081	.406	.000*	.254	.846	.370	.059*	.010*
9. Improving team performance is important when planning my training sessions	.027*	.372	.147	.344	.169	.000*	.002*	.000*		.000*	.000*	.023*	.040*	.190	.000*	.283	.288	.163	.031*	.028*
10. I would implement specific types of training in my sessions if they were shown to prevent LLIs in my players	.351	.214	.547	.766	.364	.001*	.009*	.005*	.000*		.045*	.002*	.025*	.542	.011*	.040*	.051*	.130	.184	.462
11. Preseason training is important for preventing LLIs in my players during the season	.003*	.140	.015*	.837	.081	.001*	.000*	.002*	.000*	.045*		.045*	.504	.015*	.004*	.429	.047*	.384	.144	.281
12. Incorporating lower limb prevention strategies is	.439	.064	.465	.172	.159	.177	.123	.002*	.023*	.002*	.045*		.276	.159	.164	.000	.061	.080	.030*	.115

Coach Post Season (Cross Tabs- Pearson's Chi-Square)	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
important when I plan my training sessions																				
13. I am the best source of information about how to prevent LLIs for my players	.653	.744	.098	.147	.816	.107	.223	.081	.040*	.025*	.504	.276		.527	.055*	.682	.224	.630	.194	.183
14. Players are more at risk of LLIs when playing on hard/dry grounds	.052*	.182	.293	.122	.162	.313	.236	.406	.190	.542	.015	.159	.527		.241	.322	.104	.767	.667	.061
15. It is important for players to attend training sessions if they want to play in games	.062	.125	.244	.506	.230	.001*	.001*	.000*	.000*	.011*	.004*	.164	.055*	.241		.640	.499	.178	.006*	.082
16. It is important for me to have current knowledge of lower limb injury prevention strategies	.586	.014*	.581	.007*	.010	.308	.326	.254	.283	.040	.429	.000*	.682	.322	.640		.089	.687	.645	.589
17. I would implement specific types of training in my sessions if they were shown to improve football performance and prevent LLIs in my players.	.154	.687	.245	.411	.341	.000*	.000*	.846	.288	.051	.047*	.061	.224	.104	.499	.089		.582	.087	.816
18. A serious lower limb injury could have a negative impact on a player's life	.277	.650	.452	.327	.287	.238	.345	.370	.163	.130	.384	.080	.630	.767	.178	.687	.582		.000*	.760
19. A serious lower limb injury could stop a player from undertaking their day to day employment	.192	.353	.177	.286	.530	.012*	.023*	.059*	.031*	.184	.144	.030*	.194	.667	.006*	.645	.087	.000*		.268
20. A player's chance of getting a lower limb injury whilst playing football is high	.248	.121	.501	.537	.492	.150	.350	.010*	.028*	.462	.281	.115	.183	.061	.082	.589	.816	.760	.268	

There is a significance difference between the following factors:

State and “players are more at risk of LLIs when playing on hard/dry ground” **(perceived susceptibility)**

State and “a serious lower limb injury could stop a player from undertaking their day to day employment” **(perceived severity)**

Club and “I am the best source of information about how to prevent LLIs for my players” **(regulatory self-efficacy)**

Club and “It is important for players to attend training sessions if they want to play in games” **(socio-cultural)**

Highest Coach Qualification and “a serious lower limb injury could have a negative impact on a player’s life” **(perceived severity)**

Highest Coach Qualification and “a serious lower limb injury could stop a player from undertaking their day to day employment” **(perceived severity)**

Highest Level Played and “I would implement specific types of training in my sessions if they were shown to improve football performance in my players” **(intentions)**

Highest Level Played and “It is important for players to attend training sessions if they want to play in games” **(socio-cultural)**

Years coaching and “improving team performance is important when planning my training sessions” **(socio-cultural)**

Years coaching and “pre season training is important for preventing LLIs in my players during the season” **(socio-cultural)**

Years coaching and “I would implement specific types of training in my sessions if they were shown to prevent LLIs in my players” **(intentions)**

Highest level coached at and “LLIs are not a problem for my team” **(susceptibility)**

Highest level coached at and “pre season training is important for preventing LLIs in my players during the season” **(socio-cultural)**

Highest level coached at and “I am the best source of information about how to prevent LLIs for my players” **(regulatory self-efficacy)**